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ABSTRACT

This thesis is concerned with the development and appraisal of video-tape clips used in training pre-service teachers in mathematics. The video-tapes (on file in the television studio of the College of Education at the University of Illinois in Urbana) show high school mathematics teachers in real classroom situations illustrating seven different ways that lessons might be begun: by stating goals, outlining, using an analogue, using historical material, reviewing subordinate information, giving reasons, or presenting a problematical situation. Detailed descriptions, a rationale, and written examples of each of the initiating activities are given. Transcripts of each of the 20 video-tape clips, each with a summary which highlights the initiating activities being attempted and with discussion questions related to the clip, are included. Information as to how the video-tapes were used in a series of training sessions for 12 student teachers in mathematics, and results of an evaluation by the students of the way the tapes were used, are reported. (DT)

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THE DEVELOPMENT OF SELECTED INITIATING ACTIVITIES IN THE TEACHING OF MATHEMATICS

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This thesis is primarily concerned with the development and appraisal of video-tape clips used in training pre-service teachers in mathematics. The video-tapes (which are on file in the television studio of the College of Education at the University of Illinois in Urbana) show high school mathematics teachers in real classroom situations illustrating seven different ways that mathematics teachers might begin their lessons. The seven different "initiating activities" as they are called in the dissertation are Stating Goals, Outlining, Using an Analogue, Using Historical Material, Reviewing Subordinate Information, Giving Reasons and Presenting a Problematical Situation.

The dissertation presents rather detailed descriptions, which include a rationale and written examples, of each of the initiating activities. Transcripts of each of the twenty video-tape clips developed in this dissertation are also included. In each transcript, the initiating activities being attempted are highlighted. In addition, discussion questions related to each clip are presented.

The thesis also includes information relating to how the investigator used the video-tapes in a series of training sessions conducted with twelve student teachers in mathematics. The results of an evaluation by the students of the way in which the video-tapes were used in these sessions are also reported. The observations of three university

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supervisors are used in attempting to compare the student teachers exposed to the training sessions to a group who did not receive training. The number used and the degree of success in performing the various initiating activities while doing their student teaching were the criteria used in making the comparison.

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July, 1972

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY GARTH EUGENE RUNION

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THE DEVELOPMENT OF SELECTED INITIATING ACTIVITIES IN THE TEACHING OF MATHEMATICS

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CHAPTER ONE

INTRODUCTION

Some Inadequacies of Teacher Education Programs

Among the many elements of all teacher training programs, probably none is more important than the student teaching component. Most teacher educators and student teachers likely would agree with Conant (1963) when he says, "The one indisputably essential element of professional education is practice teaching [p. 142]." Despite its importance, however, one does not have to search the literature extensively to find references to a number of weaknesses in the typical student teaching experience. Cornish (1959), for example, cites the following shortcomings:

> (1) The period of student teaching is many times too short. Often, just when signs of progress are evident, the practice ends.
> (2) The situation is rather artificial. The cooperating teacher, the student teacher, the students and the university supervisor all know that final classroom authority rests with the cooperating teacher. The knowledge can often make the student teacher hesitant in initiating new or different ideas or procedures.
> (3) There is too much variation in the way cooperating teachers and university supervisors are selected. More often than not, selections are made on the basis of expediency rather than qualifications [p. 115].

Sorenson (1967) and Andrews (1967), among many others, point out other deficiencies of student teaching programs.

It will not be the purpose of this study to critically examine all of the ills of student teaching or to propose a panacea. The study will, however, address itself to one problem area in student teaching, namely, the provision of useful and specific comments that the student teacher receives from his college supervisor and his cooperating teacher concerning how he begins the study of his lessons.

Need for Improving the Supervisory Conference

Many writers attest to the vagueness which characterizes so many conferences between supervisors and student teachers. In a study by Lowther (1968) who used the responses of 250 student teachers at the University of Michigan, it was reported that 25% of the students were dissatisfied with the "amount and quality of specific constructive criticism provided after a teaching episode [p. 42]."

Wolfgramm (1966) feels that in some cases colleges do not define clearly enough the role of the cooperating teacher. Furthermore, he feels they could do more to communicate this role to the cooperating teacher. In his article he defines, rather extensively, some of the functions of a cooperating teacher. Some of his specific suggestions are that the cooperating teacher "have a reason for conferencing [and] outline specific areas for discussion and make your conferences constructive experiences [p. 175]."

In a study involving 75 student teachers in mathematics from Illinois State University, Coblentz (1970) concluded that cooperating mathematics teachers did not give adequate attention to the effective use of conferences with the student teachers.

Hinckley (1970) believes that:

> A student teacher is much more likely to show steady improvement if instead of presenting him with a list of flaws, his supervising teacher focuses on one or at the most two problems in each interview. The simple problem of pacing the lesson, for instance, could provide the focus for a conference [p. 33].

In his book, Crisis in the classroom, Silberman (1970) makes the remark, "Students receive incredibly little feedback on their performance, . . . the teachers in whose classrooms they practice usually have no conception of education from which to criticize and evaluate their teaching [p. 451]."

In most student teaching programs, learning has been through imitating the cooperating teacher. The supervisory conferences (by both the cooperating teacher and the supervising teacher) tend to be sessions where the student teacher's performance is compared to that of the supervisor's had he been teaching the class. Thus, student teaching becomes an apprenticeship "since a large body of research suggests that the classroom teacher with whom students do their practice teaching exerts a decisive influence on their teaching style [Silberman, 1970, p. 298]." As Travers (1969) has pointed out, however,

> Student teaching must . . . be more than an apprenticeship . . .
>
> Student teaching must consist of much more than mere imitation of a master teacher. There must be analysis, interpretation, and discussion of instructional strategies--preferably on the job [p. 11].

A final remark that is related to the weaknesses of many supervisory conferences is provided by Bebb, Low, and Waterman (1969) who write that,

> Supervisors must focus their attention and activities on the central matters of teaching . . . such as questioning, controlling, responding, structuring, and so forth. Too often supervisors have given most attention to peripheral matters such as appearance, mannerisms, gestures, and the like, to the exclusion of more important matters of teaching and learning [p. 8].

Objectives of the Study

The quotations of the previous section suggest a need for greater specificity in the supervision of student teachers. Often these students are given only general suggestions as to how they might improve their teaching. One reason for this generality is that teaching is an extremely complex activity. During a single class period, so much happens so quickly that even an experienced supervisor is hard-pressed to notice everything. This is particularly true of supervisors and cooperating teachers who have never given much thought to those discrete activities that teachers perform while teaching.

It therefore seems incumbent on teacher educators, who are interested in improving the quality of supervision and hence of the student teaching experience, to examine analytically what it is that teachers do while teaching. The results of such analyses need to be transmitted to the students and used as focal points for the critique sessions that occur between the student teachers and their supervisors. Without the clearer conception of teaching resulting from such analyses, it seems rather futile to expect that the supervision of student teachers will be substantively improved. Koran (1969) puts it this way:

> . . . First, it is essential that a supervisor have clearly in mind the behavior he wishes to influence so that his feedback can be specific and so that the supervisee will know what or how to change as a result of supervision. The component parts of the behavior must be clearly communicated to the supervisee. This can be done by showing the supervisee a video tape which highlights the desired behavior in the context of a lesson . . . [p. 120].

One approach to the analysis of teaching is to conceive of it as a series of activities in which teachers engage. For example, Henderson (1957, 1965) has suggested that some of these activities are explaining, defining, justifying, generalizing, relating and demonstrating. Cooper and Stroud (1966), in a more general classification than Henderson's, have noted that teachers vary the stimulus situation, reinforce, ask questions, use audio-visual materials, establish closure and engage in certain activities whose primary function is to introduce the lesson. Clearly a single dissertation cannot examine all of the above activities in any depth. In this investigation, therefore, only the last activity mentioned, namely, that one whose function is to introduce the lesson, will be considered,

Briefly then, the first objective of this thesis is to develop and illustrate some of the ways in which mathematics teachers can begin their lessons. These various ways of beginning lessons will be illustrated by using video-tape clips of high school mathematics teachers.[1] The teachers will be shown in actual classroom situations attempting to use one or more of the ways enumerated in Chapter Two for beginning lessons. These ways of beginning lessons will be called initiating activities according to the following definition:

> Definition: The verbal and nonverbal activities in which a teacher engages when beginning his lesson will be considered initiating activities if:
>
> 1. they are relatable of the lesson, and
> 2. they attempt to serve at least one of the following functions:
>   - (a) to gain the student's attention,
>   - (b) to arouse the student's interest in the lesson,
>   - (c) to organize the lesson,
>   - (d) to show how the content of the lesson is dependent upon previously learned subject matter in mathematics,

---

[1] These video tapes are on file in the University of Illinois College of Education Video-Tape Library.

(e) to establish a common frame of reference between the students and the teacher, or

(f) to give the student a sense of purpose or direction in studying the lesson.

The second objective of this thesis is to appraise the effectiveness of the materials (which were developed in meeting the first objective) in training sessions with student teachers. The purposes of the training sessions are (1) to see whether the sessions have any observable effects on the way in which student teachers initiate their lessons in mathematics when they get in the field, and (2) to use the comments and suggestions originating in these sessions as a basis for revising the training materials and the way in which they are used in future training sessions.

Intended Audience for the Dissertation

It is intended that this study will serve two groups of readers. First, it will provide for the mathematics teacher educator (included here are both college and public school personnel) some specific ways in which teachers can initiate lessons in mathematics along with logical and psychological rationales for the use of each. Such information will be a small, but hopefully a significant step, in acquiring a useful conception of the nature of teaching. As a result, these educators may be in a better position to make specific suggestions as to how student teachers might improve their teaching. Secondly, the study will provide both beginning and experienced teachers with a number of suggestions on how they might vary the way in which they begin their lessons. It is anticipated that through the use of the materials, these teachers will be challenged and motivated to spend more preparation time in planning how they might best utilize initiating activities. This experience will presumably enhance both their versatility and effectiveness in promoting learning.

The materials to be developed in this dissertation have potential use in a variety of teacher training settings, such as the following:

1. as supplementary material in pre-service methods courses, for example, to motivate discussion concerning initiating activities or other aspects of various teaching behaviors,
2. in training supervisors,
3. by student teacher supervisors with individual students who may be particularly weak in beginning a lesson,
4. by teacher training personnel with groups of student teachers in the field in seminar settings,
5. by classroom teachers as part of an in-service training program, and
6. by individual beginning teachers who are interested in self-improvement.

Importance of Initiating Activities

Why should one element of a teacher training program concern itself with making prospective teachers aware of initiating activities?

Crosswhite (1970) has observed:

> Too many lessons have a weak beginning. Experienced teachers know the importance of the first five minutes of a class--know that they do much to establish the tone for the entire period; student teachers seem to assume that lessons are somehow self-starting. The initial word used most frequently by student teachers seems to be 'Yesterday.' ('Yesterday we were . . .') We can applaude this attempt at continuity, but it is too often

> an indication that no thought has been given to getting the lesson off the ground. There are only two openings that might be thought weaker than this interrupted-conversation gambit. Both have been observed frequently. The first of these is the gambit of 'Are there any questions?'; it may be inherited by the beginning teacher from his college instructors, among whom it seems to enjoy great popularity. The second, 'Let's go over the homework,' is in fact a potential pitfall. There seems to be a widespread feeling that homework is something that has to be 'gone over,' preferably at the beginning of each period. If the homework has been carefully planned to lead into the day's lesson, this can be a powerful opening. But too often the teacher ends up spending half the class period in this activity, and at the end the student may know no more than that he got some answers correct and some incorrect. The teacher then finds that not enough time remains to do justice to teaching the new material, so he gives a couple of quick examples and the next assignment [pp. 318-319].

It is relevant to note Crosswhite's observation that what the teacher does early in a class period is an important factor in "establishing the tone for the entire period." Further evidence making the study of initiating activities important for teachers is found when one reviews the literature related to a concept known as psychological set. We find Gibson (1941), who has made an extensive review of the literature on set, saying that:

> At about the turn of the century it began to be realized that the events in a psychological experiment--reactions, associations, judgments, or thoughts--were determined by something other than the reportable events themselves and that this was itself a psychological problem. The instructions given by the experimenter could be shown to be a source of this determination. More particularly, the subject, having been given a task, had adopted for the duration of the experiment a task-attitude. This task-attitude or set, as it was called was demonstrated to be the powerful determiner of a subject's reaction in an experiment rather than the stimuli or their associative tendencies [underlining added] [p. 783].

In the years since the discovery of the set phenomenon, a large number of investigations have been made using a concept of set as one of the variables. Gibson (1941), in his review of many of these studies, attempted "to discover a common nucleus of meaning for the term mental set and its variants [p. 810]." He concluded that "no common meaning can be discerned . . . [p. 810]." In spite of the ambiguous, and sometimes elusive, uses of the word "set," several studies which make use of a concept of set have relevance to initiating activities and hence will be briefly discussed. The first five studies which follow have at least two characteristics in common. First, the term "set" in each is used to mean "a predisposition to respond." Secondly, the results of each study make clear that what a teacher says or does before giving students a task or before new material is taught has a significant effect on the students' responses to the material.

A study by Fisher (1958) has as its general hypothesis: "Systematic differences in the perceptions of public high school students will be brought about by differences in teacher verbal introductory remarks [p. 8]." Fisher used a carefully constructed article containing equal amounts of information on smog and Pittsburgh, Pennsylvania. Students were divided into four groups according to the type of oral introduction to the lesson that was used in each group. Statistical analysis of immediate and delayed recall tests prompted Fisher to conclude that "Specific directions bring about higher test performance not only in the areas focused upon, but also in the materials to which attention was not called [p. 65]."

In attempting to ascertain the interrelationships between the three variables, perceived cognitive closure, perceived instructional set, and text anxiety, Fortune (1965) concludes that, from the standpoint of student achievement in a lecture situation, both set and closure are important. Specifically, he concludes that "perceived instructional set will be more related to student performance in the lecture method of presentation than it will be in the programmed learning media [p. 10]."

Aubertine (1963) demonstrated experimentally that student teachers, who were trained in set induction techniques, were judged to be more effective than those student teachers who were not so trained. The high school students, who were taught in a micro-teaching setting by the student teachers, used a specially prepared Teacher Demonstration Rating form in evaluating the student teachers' performances.

Replicating the work of Aubertine, Schuck (1968) reports that:

1. The pupils of teachers trained in the deliberate skill of set induction made significant gains in achievement over the pupils in the control group beyond the 0.01 level of confidence regardless of the version of the BSCS curricula employed.
2. The pupils of teachers trained in set induction techniques judged their teachers to be significantly more effective beyond the 0.01 level of confidence regardless of the version of BSCS curricula employed [p. 116].

Schuck (1971a) replicates his earlier study in an effort to correct a deficiency. Speaking of his 1968 work, he comments:

> The research design employed in this study left one important question unanswered. Were the results reported [see above] caused, as was assumed, by the additional four hours' training in the skill of set induction given the experimental group; or did this group, due to the additional training in the substantive area (a BSCS unit on respiration), become more proficient than the control group which was given no training? [p. 386]

By making appropriate modifications in his earlier design, Schuck shows that there is no significant difference in teacher achievement in the units on circulation and respiration between those teachers in the experimental and control groups. He thus concludes that it was indeed the training in set induction that resulted in the significant gains in achievement for the experimental group rather than the fact that the teachers so trained had a better knowledge of the subject matter (p. 390).

Other examples of studies dealing with the set phenomenon that tend to justify the importance of a consideration of initiating activities for teachers include the following.

Siipola (1935) demonstrates very clearly the differential effects that written instructions can have on the perceptions of students. Two groups of students were exposed tachistoscopically to the same list of ten items [sic] (horse, baggage, chack, sael, wharl, monkey, pasrort, berth, dack and pengion). One group was informed beforehand that "Most of the words you will see have to do with animals or birds. Set yourself accordingly so that you will perceive as many of the words as possible [p. 29]." The other group's directions were identical except that the words "animals or birds" were replaced by "travel or transportation." The results of the responses of each group to the ten items revealed that the subjects of the first group perceived six times as many terms as animal or bird words as did the subjects in group two. Also, the second group perceived five times as many items as travel or transportation words as did those of group one. "Further striking evidence of the effective operation of the sets is given by the fact that some subjects in each group perceived all ten items in congruence with the specific set established [p. 30]."

By using ambiguous anagrams, and by employing verbal instructions to establish a set in the subjects, Rees and Israel (1935) were able to influence "definitely and consistently which one of alternative solutions would be obtained [p. 20]."

Irion (1948) suggests that:

> There is, however, a possibility that a large portion of the forgetting loss which occurs under conditions wherein there is no formal practice on an interpolated learning task may be attributable to a loss of set to perform the activity involved [p. 338].

Irion proposes in his article that one way of reducing this "loss of set to perform" is by using, what he calls, warm-up activities. These warm-up activities are similar to the learning activity and serve to maintain the subject's set to perform. Studies by Irion (1949) and Irion and Wham (1951) confirm his hypothesis that warm-up activities which precede relearning of certain materials do result in a significant reduction in the amount of forgetting experienced by a subject. Thune's (1950) work also demonstrates the facilitative effects on learning of preliminary warm-up activities.

Irion and Thune's work is interpreted as lending support to the importance of initiating activities for teachers. For, while their work is perhaps not directly applicable to a classroom setting, it does tend to show how activities which immediately precede the learning of certain materials can markedly influence the effectiveness of this learning.

A study by Wittrock (1963) demonstrates the effect of written instructions on the learning of a 2,500-word learning passage on Buddhism. Before reading a passage on Buddhism, college students (in four different treatment groups) were provided with a short introduction which instructed them to either learn and remember (a) similarities, (b) differences, or (c) similarities and differences between Buddhism and

Christianity. A fourth group (d) was the control. The subjects in this group were instructed merely to understand and remember the Buddhism material. Immediate test results on the Buddhism material as well as a delayed (3-week) test of retention revealed significant differences between the mean of the group which was instructed to look for differences (group b) and the mean of the control (group d). Group b had the higher scores. The mean of the group that was instructed to look for similarities and differences between Buddhism and Christianity (group c) was also significantly higher than the mean of the control. The mean of the group who was looking for similarities only (group a) was also higher than the control group's mean, although not significantly so.

The relative ease with which a college instructor can influence the judgments of his students by the remarks he makes is shown in an article by Tanner (1968). Seven classes of students were asked to evaluate the effectiveness of a filmed lesson in science using a 50-item rating scale. One class served as a control and no bias was introduced when the film was shown and the rating scale administered. In the other treatment groups,

> . . . the following influences were imployed following the viewing of the lesson: (1) instructor made negative comments, (2) instructor made positive comments, (3) instructor and student confidant made negative comments, (4) instructor and student confidant made positive comments, (5) outside 'expert' made negative comments, and (6) outside 'expert' made positive comments [p. 33].

Tanner reports significant differences, in the predicted direction, in all experimental groups but one when compared to the control.

A study by Traylor (1968) investigates the possibility of reducing attitude errors in solving attitude structured syllogisms by informing the subjects ahead of time "of the possibility of attitudes toward the conclusions influencing his judgment of the validity of the conclusions [p. 4]." Traylor indicates that "The set was induced by presenting Ss with printed information suggesting that their attitudes toward the conclusions of the syllogisms might interfere with reasoning [p. 4]." He concludes (as a result of a statistical analysis) that induction of the above mentioned set is significantly effective in reducing the number of attitude errors in syllogistic reasoning.

The results of an investigation by Thisted and Remmers (1932) "tend to establish a somewhat slower drop in the forgetting curve when a temporal set is introduced that delayed recall will be required [p. 267]." Here, as in some of the previous studies, the set was induced by written directions to the subjects.

Ausubel (1968) sees much value in the use of introductory material in meaningful verbal learning situations. In fact, his work on learning theory leads him to suggest the utilization of a special type of initiating activity which he calls an advance organizer. In order to understand this concept, one must have some knowledge of Ausubel's theory of learning. Below is a brief sketch of this theory.

Ausubel (1962) distinguishes between reception and discovery learning "on the basis of whether the content of the learning task (i.e., what is to be learned) is presented to or independently discovered by the learner [p. 213]." He also makes an important distinction between rote and meaningful reception learning.

> . . . both reception and discovery learning can be either rote or meaningful depending on the conditions under which learning occurs . . . In both instances meaningful learning takes place

> if the learning task can be related in nonarbitrary, substantive (non-verbatim) fashion to what the learner already knows, and if the learner adopts a corresponding learning set to do so. Rote learning, on the other hand, occurs if the learning task consists of purely arbitrary associations, as in paired-associate, puzzle-box, maze, or serial learning; if the learner lacks the relevant prior knowledge necessary for making the learning task potentially meaningful; and also (regardless of how much potential meaning the task has), if the learner adopts a set merely to internalize it in an arbitrary, verbatim fashion (that is, as an arbitrary series of words) [Ausubel, 1962, p. 24].

It is significant that Ausubel (1962) thinks that "Meaningful learning of verbally presented materials constitutes the principal means of augmenting the learner's state of knowledge, both within and outside the classroom [p. 215]."

> The model of cognitive organization proposed for the learning and retention of meaningful materials assumes the existence of a cognitive structure that is hierarchically organized in terms of highly inclusive conceptual traces[2] under which are subsumed traces of less inclusive sub-concepts as well as traces of specific informational data. The major organizational principle, in other words, is that of progressive differentiation of trace systems of a given sphere of knowledge from regions of greater to lesser inclusiveness, each linked to the next higher step in the hierarchy through a process of subsumption . . .
>
> Thus, as new material enters the cognitive field, it interacts with and is appropriately subsumed under a relevant and more inclusive conceptual system. The very fact that it is subsumable (relatable to stable elements in cognitive structure) accounts for its meaningfulness and makes possible the perception of insightful relationships. If it were not subsumable, it would constitute rote material and form discrete and isolated traces.
>
> ---
>
> [2] The term, 'trace' is used here simply as a hypothetical construct to account for the continuing representation of past experience in the nervous system and in present cognitive structure . . . [Ausubel, 1962, pp. 216, 217].

Several variables that influence meaningful verbal learning become quite important in Ausubel's hierarchically organized subsumptive theory.

> One important variable affecting the incorporability and longevity of new meaningful material is the availability in cognitive structure of relevant subsuming concepts. . . .
>
> A second important factor presumably affecting the retention of a meaningful learning task is the extent to which it is discriminable from the established conceptual systems that subsume it. . . .
>
> Lastly, the longevity of new meaningful material in memory has been shown to be a function of the stability and clarity of its subsumers. . . . Factors probably influencing the clarity and stability of subsuming concepts include repetition, their relative age, the use of exemplars, and multicontextual exposure [Ausubel, 1962, pp. 219,220].

All three of the above variables can be affected by making use of Ausubel's advance organizers. The advance organizers are generally of two types, expository and comparative. The expository organizers are used when the new learning material, which they precede "is almost completely unfamiliar in the sense that cognitive structure is barren of even generally related concepts [Ausubel, 1961, p. 266]." In this case, the purpose of the organizer is to provide cognitive scaffolding to which the new material can be related. The comparative organizer is used when the new material is a variant of related, previously learned concepts which are already established in cognitive structure. In such circumstances, the major role of the organizer is "to increase the discriminability of the learning passage from analogous and often conflicting ideas in the learner's cognitive structure [Ausubel, 1961, p. 266]." In both types of organizers, however, the material is presented at a high level of generality and inclusiveness.

Several studies (Ausubel, 1960; Ausubel and Fitzgerald, 1961, 1962; Ausubel and Youssef, 1963; Scandura and Wells, 1967; Stinebrink, 1971) give support for the use of introductory advance organizers to enhance the meaningful learning of material. Ausubel and Fitzgerald (1962) report that "The facilitating effect of purely expository organizers, however, typically seems to be limited to learners who have low verbal . . . ability, and hence presumably less ability to develop an adequate scheme of their own for organizing new material in relation to existing cognitive structure [Ausubel and Fitzgerald, 1962, p. 137]." Somewhat contrary to this last result is the conclusion of Grotelueschen and Sjogren (1968) that ". . . given a complex learning task, those of high ability appear to benefit as much from introductory materials [advance organizers] as those of low ability did in a complex task [p. 200]."

The present chapter has attempted to do several things. The section entitled, Some Inadequacies of Teacher Education Programs, highlighted some weaknesses of many teacher education programs. Particular emphasis was given to one problem area, namely, the lack of specific, constructive criticism which characterizes many conferences between student teachers and those university and public school personnel charged with their supervision. In the second section entitled, Objectives of the Study, the two major objectives of the thesis were explained. Briefly, these objectives were (1) to develop and illustrate, utilizing videotapes of real teachers, various ways that mathematics teachers might begin their lessons, and (2) to appraise the effectiveness of the materials (which were developed in meeting the first objective) in a series of training sessions with a small group of student teachers. The different ways of beginning lessons were labeled initiating activities, and a formal definition of these activities was included in the section entitled, Objectives of the Study. The final section of Chapter One, Importance of Initiating Activities, provided references from the literature which tended to corroborate the importance of a study of initiating activities for prospective teachers.

CHAPTER TWO

IDENTIFYING THE INITIATING ACTIVITIES

As stated in the first chapter, one of the objectives of this thesis is to develop and illustrate some of the ways that mathematics teachers can begin their lessons. The present chapter, therefore, contains a commentary, a rationale and some written examples for each of the seven initiating activities identified in this study. Before launching into a detailed description of the initiating activities, however, it seems appropriate to reproduce the definition of an initiating activity as given in the previous section entitled, Objectives of the Study.

> Definition: The verbal and nonverbal activities in which a teacher engages when beginning his lesson will be considered initiating activities if:
>
> 1. they are relatable to the lesson, and
> 2. they attempt to serve at least one of the following functions:
>   - (a) to gain the student's attention,
>   - (b) to arouse the student's interest in the lesson,
>   - (c) to organize the lesson,
>   - (d) to show how the content of the lesson is dependent upon previously learned subject matter in mathematics,
>   - (e) to establish a common frame of reference between the students and the teacher, or
>   - (f) to give the student a sense of purpose or direction in studying the lesson.

An Overview of Selected Initiating Activities

The various initiating activities listed in Table 1 have been gleaned from several sources--the author's own teaching experience, his observations of other teachers and from reading some of the literature on teaching. The activities listed certainly do not exhaust the ways available to mathematics teachers for beginning their lessons. They do, however, represent a fairly wide range of activities that are appropriate for use at almost any ability and maturity level.

Table 1

Summary of Various Initiating Activities

Name of initiating activity	In using this initiating activity, the teacher:
1. Stating Goals	Begins the study of the lesson by stating clearly the goal of the lesson.
2. Outlining	Presents either a written or oral outline of the major points of the lesson.
3. Using an Analogue	Uses an analogue within the experiential field of the students that is related to the content of the lesson.
4. Using Historical Material	Makes use of some piece of historical information (biographical information of a famous mathematician, a problem with an interesting history, etc.).
5. Reviewing Subordinate Information	Reviews certain topics whose comprehension he feels is a prerequisite for understanding the lesson.
6. Giving Reasons	Gives reasons to the class as to why they are studying the lesson.
7. Presenting a Problematical Situation	Begins the study of the lesson by presenting the students with a problem or a contradictory state of affairs whose resolution is related to the material to be covered in the lesson.

General Comments

1. While all of the examples of the various initiating activities in this dissertation are from the area of secondary school mathematics, there is no reason (other than the fact that the author's area of specialization is mathematics) why this need be so. In other words, it would seem that the initiating activities listed could find use in other disciplines as well.

2. The activities appear to be appropriate at many grade levels.

3. The initiating activities can be used in various combinations. For example, "Stating Goals" and "Outlining" are two that work well together. Also, these two are easily used with many of the others.

4. It is not always possible to identify unequivocally where the teacher stops using an initiating activity and begins the lesson. Such a fine line of demarcation is, however, not really crucial to meet the objectives of this study as described in the section entitled, Objectives of the Study. The important thing is that we are able to roughly locate a portion of classroom discourse whose primary function is to introduce the lesson.

5. Somewhat related to the identification of initiating activities is the fact that there may be occasions when the content of the initiating activity is also part of the lesson to be taught. For example, it is possible that a teacher could use some piece of historical information to initiate the study of some topic, and, at the same time, view the historical material as part of the lesson to be learned. In other words, there are times when, in addition to being used to introduce new material, the content of the initiating activity could also be one of the goals of the lesson. (See, for example, Transcript 18, page 111.)

6. Attention is called to the various means by which each of these activities can be effected. Each of the seven initiating activities represents only very general ways of introducing lessons. Within each classification, the teacher has much freedom in deciding how he will actually use a particular activity. For instance, number seven, Presenting a Problematical Situation, can be used in many ways--the teacher can state orally some problem, the problem can be shown to the class using an overhead projector (perhaps without comment), the teacher can prearrange to have a student present the problematical situation, a film or filmstrip (or portion thereof) can be used as a medium for the presentation of a problem.

The Seven Initiating Activities

In the seven sub-sections that follow, a commentary, a rationale and some examples of each of the seven initiating activities will be given. The commentaries contain a brief statement showing how each activity is related to the definition of an initiating activity given on page 18. Also, the commentaries provide further information describing each activity. The rationales given represent the opinions of mathematics educators, teachers and educational psychologists regarding the worth of each of the initiating activities. Some of these opinions are based upon the experiences and beliefs of the various authors while others (such as those presented with "Using an Analogue" and "Presenting a Problematical Situation") have some experimental base. It should be emphasized that the section entitled Importance of Initiating Activities (page 7) contains other references which are viewed as providing additional rationales (of a somewhat more general nature) for the various initiating activities.

Stating Goals

Commentary. Stating the goals of a lesson is seen primarily as giving the student direction in studying the lesson, but also could be viewed as an attempt to gain the student's attention as well as to arouse his interest (e.g., see the comments by Rosenberg (1970) below).

In using this initiating activity, the teacher must first decide precisely what his goals are in teaching the lesson. By having clearly in mind what he wishes to accomplish, the instructor is in a much better position to make decisions regarding teaching strategies available to him for attaining his goals. The teacher then informs the class of the objectives of the lesson. "He should provide the student with statements of instructional objectives that the student can understand when he first sees them [Mager, 1968, p. 58]." It is important that the goals given to the students are not so broad or general as to be essentially meaningless to them. This does not imply, however, that the teacher should be unaware of general course or unit objectives. In fact, without an understanding of the broader objectives, a teacher may fail to emphasize important connections between individual lessons. Crosswhite (1970) summarizes well some of the questions that teachers need to ask themselves concerning planning with respect to objectives:

1. Am I really aware of the broad objectives I am trying to achieve in this course?
2. Have I formulated unit objectives that refine and can be expected to add up to these course objectives? Is the same relation true of my lesson and unit objectives?

3. Are the objectives specific enough and clear enough to give direction to my decisions regarding content, methods, and evaluation?
4. Have I tried to state my objectives in terms of behaviors that I can observe and measure?
5. Have I attended to objectives concerning attitudes, interest, and so on, as well as to those that are content-oriented?
6. Have I explored the relation between the objectives of this unit and other units? Between this lesson and other lessons?
7. Do my plans include provision for helping my students answer such questions as:
    a) What are the immediate purposes of this activity? What are the long-range purposes?
    b) What is expected of me? What are my responsibilities? How will I be evaluated?
    c) How is this activity related to activities that have gone before and to those that will come after? [p. 324].

Rationale. This initiating activity requires the teacher to think seriously about just what it is that he is about in teaching the lesson. Knowing exactly what he wants to do will, of course, put him in a better position for deciding what methods to use in achieving his goals. As Fehr (1953) says,

> 1. There must be a goal on the part of the student to learn. The learner must be aware of this goal. Thus a teacher must not only know why a student should learn to solve a quadratic equation, but he must know how to transform this why into a recognized goal on the student's part. Motivation conditions the quality of the learning. A pupil will stop counting and learn addition facts when counting becomes inadequate for him and he desires a more efficient method [p. 30].

Gronlund (1970) suggests stating instructional objectives as learning outcomes. According to him, these learning outcomes or end-products include such things as "Knowledge, Understanding, Thinking skills, Performance skills, Communication skills, Computational skills, Work-study skills, Social skills, Attitudes, Interests, Appreciation and Adjustments [p. 3]." He also lists several contributions that stating instructional objectives as learning outcomes has to the educational process. They are:

> 1. It [the instructional objective] provides direction for the instructor, and it clearly conveys his instructional intent to others.
> 2. It provides a guide for selecting the subject matter, the teaching methods, and the materials to be used during instruction.
> 3. It provides a guide for constructing tests and other instruments for evaluating student achievement [p. 4].

He also suggests that, "If the expected learning outcomes are conveyed to the students, these outcomes also serve as a guide for the student's learning activities--both in and out of the classroom [Gronlund, 1970, p. 4]."

A further rationale for this initiating activity is provided by Rosenberg (1970) who lists "Goals of Instruction" as one of the ways of generating interest in a mathematics classroom. He says,

> . . . The opportunity to introduce a challenging new topic will arouse in most teachers a great deal more enthusiasm than the prospect of teaching a review lesson or proctoring an examination.
>
> Similarly the intensity of a student's interest may depend on the lesson's objectives. A lesson designed to provide routine drill or mere memorization of mathematical facts may be less interesting than a lesson whose goal is to stimulate thought or intellectual curiosity [p. 143].

From what Rosenberg is saying, we could infer that informing students of the goals of the lesson could have an influence on the way in which they respond to the lesson. It behooves the teacher, therefore, to present the goals of the lesson in a manner that he feels will maximize student interest.

This initiating activity can also function to give the student a sense of direction. That is, the teacher, by making it clear to his students where the lesson is going, puts them in a better position to understand any intervening steps that he might go through in reaching his goal. As Gagné (1965) expresses it,

> . . . unless students know what the objectives are, they are likely to resort to memorization and mechanical completion of exercises in textbooks or workbooks, rather than carrying out relevant sorts of learning activities. When one tells the student what he is expected to do after he learns, this is not 'giving him the answer.' Rather it is providing him with a goal which he himself can use to organize his own learning activities. Of relevance here is a study of Mager and McCann (1961), who found that when engineers were told the objectives of their learning they succeeded in reaching them in much less time than under other instructional conditions [p. 9].

We also find Crosswhite (1970) saying that,

> Until the teacher's objectives have been transmitted to his students--in fact, until they become student objectives--their achievement is doubtful. The planning process with respect to objectives should not be considered complete until some thought has been given to how these objectives might be transferred to students. It may be true that objectives are communicated as much by what a teacher does as by what he says. Certainly students learn to 'read' a teacher. They pick up cues as to what is expected of them from questions the teacher asks, activities he plans, homework he assigns, and quizzes and tests he gives. The more consistent a teacher's behavior is with the objectives he claims to be seeking, the more likely students are to see those objectives clearly. Still, we all know that students pick up false cues too.
>
> It is puzzling that teachers so seldom attack this problem directly. Perhaps they take too literally the admonition that telling is not teaching. Or maybe they adhere to the adage that actions speak louder than words. Whatever the reason, few classes have been observed in which there was any direct reference to the objectives being sought. . . . Every teacher should, by direct reference or planned innuendo, try to share his objectives with his students. Surely there can be little defense for the typical practice that forces students to guess the objective [p. 322].

Examples. For a particular lesson in geometry, the goals might be to "know the various relationships between the angles formed by two coplanar lines and a transversal." From trigonometry, the goal of a lesson might be to "be able to rapidly sketch the graphs of the six trigonometric functions without plotting a multitude of points."[2]

Outlining

Commentary. In outlining the lesson, the teacher is providing organization for what will be covered. This organization can, in turn, provide the student with direction in studying the lesson. In addition, if the outline contains points which are review items, this initiating activity can be used to show how the lesson is dependent upon previously learned material.

This initiating activity is a natural ally of Stating Goals. Each, however, can be used separately. Used with activity number one, the teacher, having decided upon the specific goals of the lesson, merely outlines the major points he will emphasize in attempting to reach his goals. While, when using these two activities together, it is conventional to state the goals of the lesson before listing the major points, there may be occasions when this order may be reversed. In using this activity alone, the teacher outlines the major points of the lesson. In order to do this meaningfully, of course, the teacher must have given some thought to what his purposes are even though he elects not to inform the class of his goals.

Rationale. This initiating activity has the obvious advantage of giving organization to the lesson. Thus students are in a better position to follow the development of the lesson. As a result, learning is presumably enhanced. In speaking of the way in which introductory overviews enhance learning, Ausubel (1968) claims that,

---

[2] The reader will find much helpful information for translating these general instructional objectives into specific learning outcomes by referring to Gronlund (1970).

> . . . The latter [introductory overviews or outlines of the major points of a lesson] . . . achieve their effect largely through repetition, condensation, selected emphasis on central concepts, and prefamiliarization of the learner with certain key words [p. 331].

In attempting to relate this initiating activity to Gestalt psychology, we note that in that theory "All parts related to the learning situation must be brought into focus to see the problem as a whole. Scattered elements or isolated details prevent insight [Fehr, 1953, p. 24]." Clearly this initiating activity can serve to highlight the various elements of a new learning experience and to show their relationship to the whole situation.

Indicating to students the important points in a lesson is advocated by Woodruff (1951) as an important pedagogical technique. He writes that,

> To take advantage of certain known factors of importance in efficient learning, the teacher should arrange the material to be learned in such an order that the most important ideas are seen first and lead naturally into the lesser ideas, or the ideas that are formed primarily of the subdivisions of the main issues [p. 283].

Use of this initiating activity also encourages the teacher to give some thought to how he will organize and present the lesson. Such advanced planning is useful in helping to minimize the effects of retroactive inhibition in a manner suggested by the following comments:

> . . . If it [the introduction of a new concept in mathematics] cannot be completed within the [class] period, and the students cannot be given time to bring the ideas to some sort of mastery, there will be more forgetting between then and the next class meeting than would otherwise occur. [Sometimes, due to practical difficulties] This cannot be helped . . ., although it can

> be reduced greatly by planning the attack on new material so as to allow for completion of whatever is involved in the concept or the learning exercise before the class ends [Woodruff, 1951, p. 260].

Examples. Outlining material to be taught is, to some extent, a matter of individual preference. Probably no two people could be expected to outline the same material in exactly the same way. Bearing this in mind, here are two possible outlines for the lessons whose goals were presented in the examples of the section entitled, Stating Goals.

Example One

Goals: Know the various relationships between the angles formed by two coplanar lines and a transversal.

Outline of the Lesson:

I. The concept of a transversal

II. The various categories of angles formed by two lines and a transversal

  A. Alternate angles

    1. Alternate interior

    2. Alternate exterior

  B. Corresponding angles

III. Theorems concerning the various categories of angles when the two lines are parallel

IV. Summary of the major outcomes of the lesson.

Example Two

Goals: Be able to rapidly sketch the graphs of the six trigonometric functions without plotting a multitude of points.

Outline of the Lesson:

I. Graphing the six trigonometric functions

II. Meaning of amplitude

III. Meaning of period

IV. Graphing functions of the form y = a sin kx or y = a cos kx

Using an Analogue

Commentary. In using this initiating activity, the teacher (1) selects from the common experiential field of his pupils some known object or piece of information the purpose of which is to provide a common point of reference between the pupils and the teacher. This known referent (i.e., analogue) that the teacher selects should be simple enough so that it will clarify, not obscure, the comprehension of the lesson. Having selected the analogue which he feels is appropriate for enhancing the meaning of the lesson, the instructor then (2) spends time developing the analogue. That is, he emphasizes those aspects of the analogue that are similar and relevant to the content of the lesson. Finally, (3) the teacher will insert the subject matter to be learned into his presentation. This is done by comparing the common elements of the subject matter being taught with the analogue developed in steps (1) and (2) (Aubertine, 1964, p. 11).

This is one of those initiating activities in which it is not always possible to identify unequivocally where a teacher stops using an initiating activity and begins teaching the new material. The examples given below indicate, to some degree, the difficulty one encounters in trying to determine precisely where in the discourse the teacher has stopped initiating and started teaching the main subject matter of the lesson. As mentioned in item four of the section entitled, General Comments, however, the important point is not that we can identify exactly where the initiating activity begins and ends but is instead that the teacher has, at least, spent some time in attempting to prepare the students for the content of the lesson as opposed to merely moving into it.

Rationale. The rationale for this initiating activity comes from the work of Aubertine (1964) whose study has already been referred to in Chapter One. Aubertine claims that "One of the fundamental conditions for the effective communication between pupils and teachers is the establishment and the sharing of a common frame of reference, . . . [p. 2]."

> . . . If the teacher structures his lesson in such a manner that it is directly related to the experiential field of the pupils, he has promoted the possibilities of creating a common frame of reference. . . . By so doing, the teacher facilitates the communicative process between himself and the pupils, which in turn increases the possibilities of his pupils becoming involved in and responsive to the lesson [Aubertine, 1964, p. 3].

Hence, from what Aubertine is saying, it would appear that before a teacher begins teaching the lesson, he should engage in some sort of initiating activity whose primary function is to place both student and teacher on common cognitive ground in order to "encourage pupil interest and involvement in the main body of the lesson that will follow as well as facilitating maximum teacher-pupil communication [Aubertine, 1964, p. 10]."

Examples.

Example One

Goals: Acquire skill in solving simple trigonometric equations, that is, equations that involve only one trigonometric function of a single unknown angle.

The teacher begins the lesson by displaying to the class the simple trigonometric equation $3 \sin \theta + 1 = 0$. He then relates the goal of the lesson to the students. At this point, the teacher selects as an analogue some algebraic equation involving only one unknown, say $3x + 1 = 0$. He then demonstrates the steps necessary to isolate the variable and hence obtain a solution.

Following this the instructor redirects the students' attentions to the trigonometric equation, $3 \sin \theta + 1 = 0$. He makes clear to the students the similarities in solving this equation for $\sin \theta$ and $3x + 1 = 0$ for x. At this point he notes for the students a major dissimilarity in the methods of solution, namely, that in solving trigonometric equations, one is usually forced to make use of tables of trigonometric functions.

In this example, of course, the teacher can make use of as many other appropriate analogues as he feels are necessary. It is also important to notice in this example that the analogue selected is a mathematical one. This is acceptable so long as the analogue is one within the experiential field of the pupils.

Example Two

Goal: Understand the distributive property of numbers.

For the analogue from the common experiential field of the students, the teacher selects two sections of fence illustrated in Figure 1.

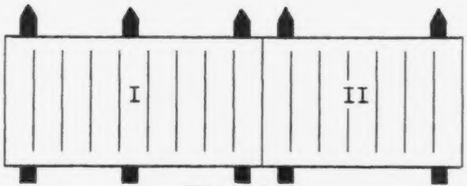

Figure 1

The teacher spends some time in emphasizing those elements of the analogue that are similar and relevant to the new material to be studied; the teacher will compare the common elements of the new concept (i.e., the distributive property) with the fence analogue. The teacher might say the following:

> A man has a fence which is six feet high and in two sections. The first section is 20 feet long and the second section is 15 feet long. He decides to paint the first section red. How many square feet of area are there in section I? The second section he decides to paint green. How many square feet are there in section II? What is the total area of sections I and II?
>
> Now suppose he decides to whitewash the entire fence (both sections). How many square feet are there to be whitewashed? Has the total area changed?
>
> Would it make any difference if the fence were $\underline{a}$ feet high instead of six feet? If section I were $\underline{b}$ feet long instead of 20? If section II were $\underline{c}$ feet long instead of 15? How would we write the area of section I now? Section II? The total area?
>
> Does the total area change when the man changes his mind from painting section I red and section II green to whitewashing the whole fence? Can we say then that $a(b + c) = ab + ac$? Why?

In discussing the "Why?", the teacher might spend some additional time comparing the common elements of the analogue with those of the new material.[3]

Using Historical Material

Commentary. This initiating activity is seen mostly as being used to gain the student's attention and to arouse his interest in the lesson. The use of historical material to introduce a lesson is not a common occurrence in mathematics classrooms. This state of affairs is probably attributable to the general unfamiliarity of secondary mathematics teachers with such material.

The actual content of this initiating activity could take many forms. It could, for example, be some biographical information regarding some famous mathematician. It could be some topic or problem that has had an interesting history or it could be a reference to the social or political conditions paralleling the discovery or development of the topic of the lesson.

Rationale. The rationale for using this initiating activity comes from teachers who are, through their own experiences, convinced of the value of using historical materials to stimulate interest in their classes. Jones (1957) sees at least three broad categories of functions which may be performed by properly used historical materials.

> . . . (1) they may clarify meanings, give insights, and sharpen understandings of mathematics itself; (2) they may give students desirable 'appreciations'; and (3) . . . they may also serve as primarily a pedagogical device for improving instruction, that is as a methodological tool [p. 59].

In the same article, Jones (1957) claims for historical topics the purely pedagogical purposes of: "(1) creating interest of the type which motivates and . . . (3) suggesting devices for introducing topics and for aiding students to 'discover' new concepts . . . [p. 62]."

---

[3] This example was provided to the author by Dr. Aubertine in a personal interview.

We find Simons (1923) saying that,

> Among the means to be used in vitalizing the teaching of mathematics in the secondary schools are to be found the applications of the subject in . . . history . . .
>
> . . . Teachers are advised to make themselves reasonably acquainted with the leading events in the history of mathematics . . . for the purpose of adding to the interest of the pupils by means of informal talks on the growth of mathematics and on the lives of the great makers of the science [p. 94].

Although Simons is advocating the use of historical materials for more than just initiating lessons, certainly he would not object to their use in such a manner.

Further support for using historical information to initiate lessons is supplied by Hassler (1929) who lists three values to be found in the history of mathematics for high school teaching. These are,

> 1. A knowledge of the history of the development of the mathematical processes he is learning will kindle the pupil's interest in the subject matter [p. 166].
> 2. A knowledge of the history of mathematics on the part of the teacher gives him a source upon which he may draw to enrich and enliven his teaching [p. 169].
> 3. A knowledge of the history of mathematics gives both pupil and teacher an appreciation of the value of the subject and its inseparable and vital connection with the development of civilization [p. 171].

Harmeling (1964) believes that historical stories can do much to stimulate interest in mathematics. He writes,

> One of the best ways to stimulate curiosity and to instill a spark of the fascination of mathematics is to relate some of the absorbing true stories with which the history of mathematics abounds [p. 258].

Henderson and Pingry (1953) also endorse the use of historical initiating activities when they write,

> A lesson to help the student understand the historic development of numbers would be very appropriate before starting a unit on complex numbers. This lesson or lessons could deal with the general development and extension of number systems, with attention to their characteristics, and rules of operation. The student would then understand complex numbers in a broader and more meaningful setting [p. 250].

The National Council of Teachers of Mathematics (1967) Cumulative index for The mathematics teacher lists many articles related to the use of historical materials in teaching mathematics.

Examples. While many examples of historical initiating activities can be given, only a few will be suggested. One possible example, of course, is suggested in the above quote by Henderson and Pingry. In addition to this, Jones, in the aforementioned article, notes the possibility of using Cardan's famous problem "Are there two numbers whose sum is ten and whose product is forty?" to introduce the study of complex numbers. Jones mentions that Cardan said that the problem was "obviously impossible." "I don't know on what basis he called it impossible but here is a good way to challenge youngsters by asking them how Cardan might have drawn this conclusion [Jones, 1957, p. 62]."

For a suggestion on how to introduce a study of the Pythagorean theorem, we find Jones (1957) saying that,

> Historical facts and speculations furnish many other suggestions for leading students to 'discover' mathematical ideas. For example, some persons have thought that the Pythagorean theorem might have been first discovered in the case of the isosceles right triangle where it is geometrically quite obvious and might have been visualized in a tile floor or wall, . . . [see Figure 2] [Jones, 1957, p. 62].

Perhaps after making comments similar to those in the quotation above, the teacher could ask the students if they could guess what relationship exists among the areas of squares AICB, IHGF and FEDC.

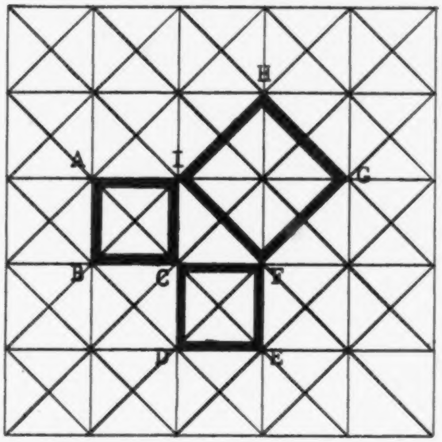

Figure 2

Steinen (1970) provides the following example of an historical anecdote which could be used to focus student's attention on the relation between central angles and their intercepted arcs. He mentions that the anecdote is "intended to promote interest and respect for mathematics in general . . .," and that the introduction "would probably take the form of a short, informal lecture [p. 381]."

> Most people know that when Christopher Columbus set out to find a new route to India it was commonly believed that the earth was flat. Many feared that Columbus might reach an edge and never return.
>
> However, not all people before Columbus's time shared this belief. In fact, more than seventeen hundred years earlier a Greek mathematician named Eratosthenes not only realized the earth was round but also calculated its circumference with an accuracy of within 1 percent of our present measurement.
>
> A lunar eclipse provided the first clue for Eratosthenes. When the earth's shadow fell on the moon, its shape was clearly curved. In addition, he knew that at noontime of the summer solstice (about June 21) the sun was directly above the city of Syene in Egypt. Evidence of this was that the sun's rays were reflected from the water in a deep well with no shadow from the well's walls. Also, a vertical rod driven into the ground cast no shadow at this time.
>
> So, sometime in the latter part of the third century B. C., at the time of the summer solstice, Eratosthenes performed the following experiment. Vertical rods were driven into the ground

at Syene and at Alexandria, which was due north of Syene. At noon the rod at Syene cast no shadow at all; the rod at Alexandria cast a short shadow. The shadow's length enabled Eratosthenes to calculate the angle of elevation of the sun, 82 4/5° [see Figure 3].

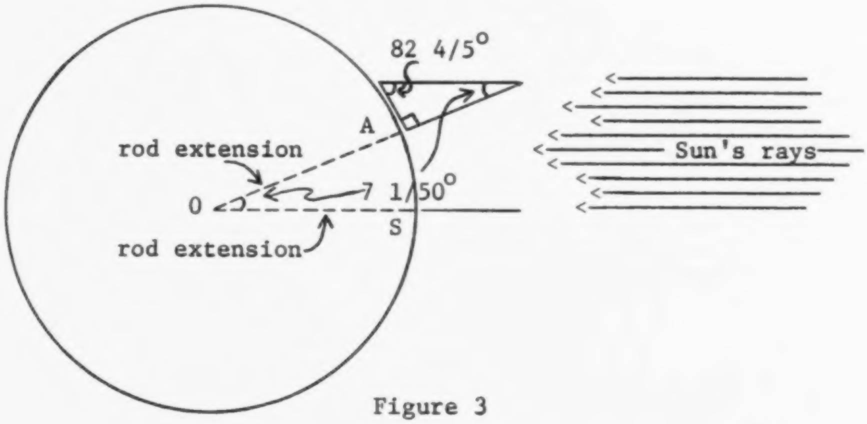

Figure 3

Since the distance from the earth to the sun was very great, Eratosthenes assumed that the sun's rays were parallel. Using the alternate interior angle theorem, he concluded that the angle at the center of the earth was 7 1/5°. (In this figure the extensions of the rods are represented by dotted lines that meet at the earth's center. Obviously the figure is not drawn to scale.)

Since 7 1/5° = 1/50 (360°), the distance from Syene to Alexandria must be 1/50 of the earth's circumference. This distance was known to be 5,000 stadia, roughly 500 miles in modern terms. Therefore,

$$\begin{aligned}\text{circumference} &= 50 \cdot 5000 \text{ stadia}\\ &= 250{,}000 \text{ stadia}\\ &\doteq 25{,}000 \text{ miles}\end{aligned}$$

[Steinen, 1970, p. 381].

For an excellent collection of topics appropriate for historical initiating activities, the reader is directed to the Thirty-First Yearbook of the National Council of Teachers of Mathematics (1969) entitled Historical topics for the mathematics classroom. Also the book by Johnson and Rising (1967) has many interesting problems as well as an extensive bibliography on many aspects of teaching mathematics.

Reviewing Subordinate Information[4]

Commentary. This initiating activity is used to show how the content of the lesson is dependent upon previously learned subject matter. In this initiating activity, the teacher spends class time in reviewing material whose comprehension he has judged is a prerequisite to understanding the content of the lesson at hand. This review can be effected in a variety of ways. For example, the teacher can use an informal lecture approach to present the items for review, or he can just mention the different items and let some of the students orally review the material for the remaining members of the class.

Regardless of the mode of presentation, it is clear that the teacher who uses this initiating activity has some important decisions to make. He must select from what could be many "subordinate knowledges" of a particular lesson those few that can reasonably be incorporated into a class period. This selection process is necessary for the following reasons: In any classroom, there are students whose understanding of subordinate information relative to a particular lesson varies. That is, there may be some pupils who understand virtually all of the subordinate concepts and principles necessary for the full assimilation of the lesson, while on the other hand, there may be some who understand only a few. Faced with this dilemma (along with certain pressures to "cover the material" in a finite amount of time), the instructor must decide on what subordinate information to review. How he does this (by making a value judgment, by item-analyzing quizzes and tests, by asking for a show of hands, etc.) is another of his decisions.

---

[4] The terms "subordinate information," "subordinate knowledges" and "learning sets" are used interchangeably in this section to refer to that subject matter, an understanding of which is a prerequisite for the comprehension of the lesson.

Rationale. The major rationale for this initiating activity is based upon the work of Gagné and Paradise (1961); Gagné (1962); and Gagné, Mayor, Garstens, and Paradise (1962) with programed learning materials. Very briefly, Gagné believes that the knowledge necessary for the understanding of a new learning situation can be visualized as a set of subordinate capabilities which he refers to as learning sets.

> . . . These learning sets are considered to be arranged in a hierarchy such that any learning set may have one or more learning sets subordinate to it in the sense that they mediate positive transfer to the given learning set. These subordinate sets in turn have other learning sets subordinate to them, and so on.
>
> Each learning set in the hierarchy is represented by a distinct class of tasks, and measured in the individual by one or more representative tasks from this class. In order for learning to occur at any point in the hierarchy, according to this theory, each of the learning sets subordinate to a given task must be highly recallable, and integrated by a thinking process into the solution of the problem posed by the task. The attainment of the final task is thus conceived to be a matter of successive attainment and 'integration' of a series of lower level learning sets, . . . [Gagné and Paradise, 1961, p. 2].

According to Gagné's and Paradise's (1961) theory, one may determine, for any given learning task, the subordinate learning sets by asking of that task, "What would the individual have to know how to do in order to perform this task, after being given only instructions? [p. 4]." By asking the same question of each subordinate learning set, one can generate a hierarchy of learning sets for any given final task. Such a hierarchy is illustrated in Figure 4 for the task of solving linear algebraic equations.

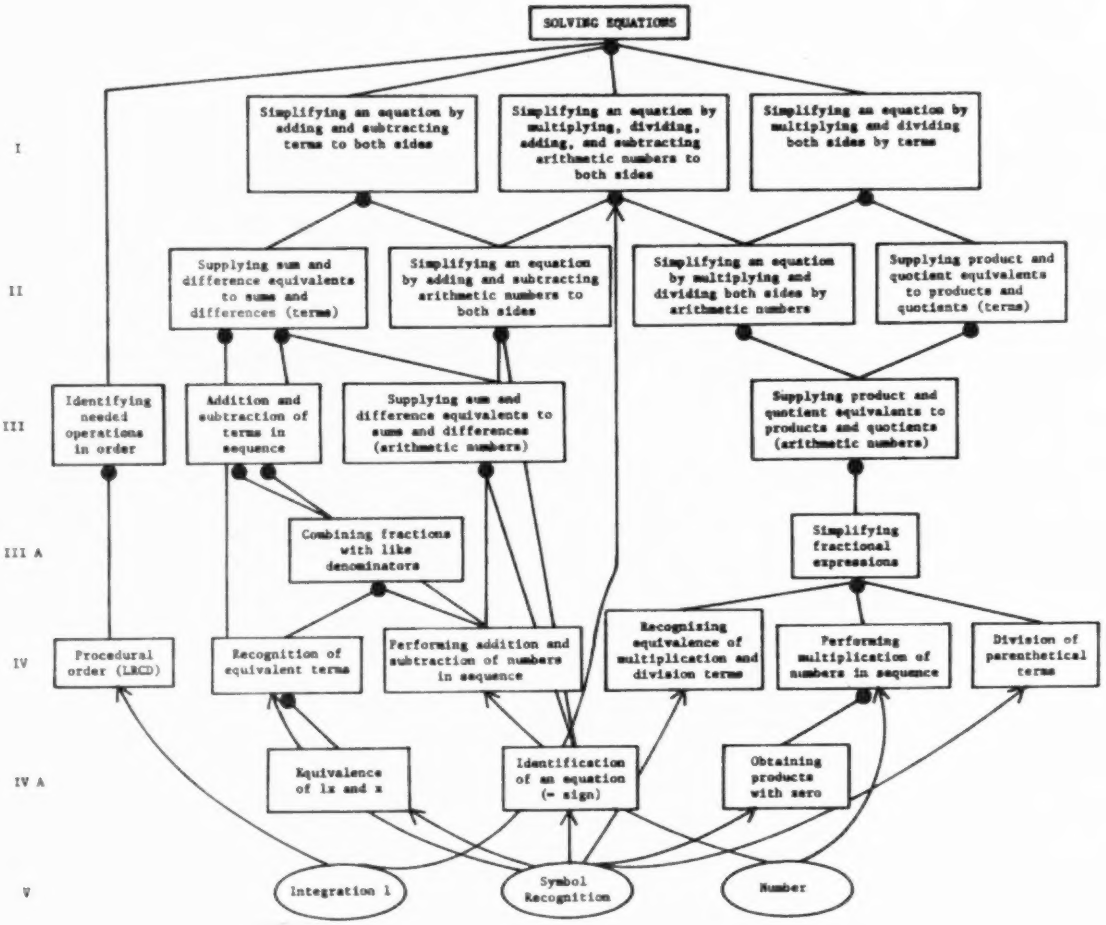
SOLVING EQUATIONS
I
Simplifying an equation by adding and subtracting terms to both sides
Simplifying an equation by multiplying, dividing, adding, and subtracting arithmetic numbers to both sides
Simplifying an equation by multiplying and dividing both sides by terms
II
Supplying sum and difference equivalents to sums and differences (terms)
Simplifying an equation by adding and subtracting arithmetic numbers to both sides
Simplifying an equation by multiplying and dividing both sides by arithmetic numbers
Supplying product and quotient equivalents to products and quotients (terms)
III
Identifying needed operations in order
Addition and subtraction of terms in sequence
Supplying sum and difference equivalents to sums and differences (arithmetic numbers)
Supplying product and quotient equivalents to products and quotients (arithmetic numbers)
III A
Combining fractions with like denominators
Simplifying fractional expressions
IV
Procedural order (LRCD)
Recognition of equivalent terms
Performing addition and subtraction of numbers in sequence
Recognizing equivalence of multiplication and division terms
Performing multiplication of numbers in sequence
Division of parenthetical terms
IV A
Equivalence of 1x and x
Identification of an equation (= sign)
Obtaining products with zero
V
Integration 1
Symbol Recognition
Number

Figure 4. Learning set hierarchy for the task of solving linear algebraic equations. (Large dots at the bottom of boxes indicate the relatedness of particular lower level and higher level learning sets, in the sense that positive transfer is predicted. At the lowest level, in ovals, are basic ability factors, whose relevance to learning sets in the hierarchy is indicated by arrows.) [From Gagné, Robert M., & Paradise, Noel E. "Abilities and learning sets in knowledge acquisition," Psychological Monographs: General and Applied, Vol. 75, 1961, No. 14, Whole No. 518.]

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The significance of Gagné's work for the initiating activity of Reviewing Subordinate Information is that

> . . . it has been verified in these studies [the three referred to earlier] that the capability of performing certain identifiable units of subordinate knowledge [i.e., learning sets] creates a high probability of acquiring a new item of knowledge; whereas the lack of capability of performing any one of these same subordinate units reduces this probability to a very low value [Gagné and Bassler, 1963, p. 123].

In other words, if a teacher assigns students the task of solving linear algebraic equations, he had better make certain that his students fully understand all of the subordinate learning sets in the above diagram. Otherwise, the students' chances for success on the final task are reduced.

It was mentioned earlier that Gagné's work has been done using programed materials. Now it is conceivable that such materials could be constructed which would ascertain where a particular student was (in terms of his knowledge) in any given hierarchy of learning sets. By appropriate branching, he could be directed through remedial frames that would correct deficiencies in certain of the learning sets associated with a given final task. His success on the final learning task would, thereby, be virtually assured. The classroom teacher, however, cannot ordinarily provide such individualized branching. As was noted earlier, therefore, it is up to the teacher to use whatever methods are available to determine the subordinate learning sets which are least understood by the most students; then to make these the items to be included in the initial review.

One may also appeal to Ausubel (1968) for support in the use of this initiating activity. He writes:

> By insisting on consolidation or mastery of ongoing lessons before new material is introduced, we make sure of

> continued subject-matter readiness and success in sequentially organized learning. This kind of learning presupposes, of course, that the preceding step is always clear, stable, and well-organized. If it is not, the learning of all subsequent steps is jeopardized. Thus, new material in the sequence should never be introduced until all previous steps are thoroughly mastered . . .
>
> Abundant experimental research . . . has confirmed the proposition that prior learnings are not transferable to new learning tasks until they are first overlearned. Overlearning, in turn, requires an adequate number of adequately-spaced repetitions and reviews. . . . [p. 159].

Hence, Ausubel would not only favor the use of reviews, as suggested by this initiating activity, but would urge their repeated use in order to promote overlearning of material that is to be transferred. The case for repetition of learning material to facilitate its overlearning and thus its retention is also encouraged by Woodruff (1951) who refers to such a practice as "a sound principle of study [p. 262]."

Examples. One example of the use of this activity can be imagined by referring to the hierarchy shown earlier (see Figure 4). The goal is to teach the students to solve linear algebraic equations. Now suppose that the teacher makes a judgement (based upon his familiarity with the class's general ability) that a number of students are having difficulty with some of the procedures identified in row II of the hierarchy. The teacher would then select several representative problems that would illustrate the skills identified in row II. He might then work through these examples at the board, or perhaps give the students the problems on a worksheet or maybe let the students work in small groups. The point is that the teacher spends some time, prior to actual involvement with the main learning task, in reviewing subordinate information.

A final instance of this activity is noted by referring to the second initiating activity, Outlining (see page 28). Noting the second example given on that page, it can be seen that before discussing how to sketch graphs of such trigonometric functions as y = a sin kx and y = a cos kx the teacher plans to spend some time in reviewing the topics labeled I, II and III.

Giving Reasons

Commentary. Giving reasons for studying a particular topic is used primarily to give the students a sense of purpose or direction in their work. Also, this activity can be interpreted as motivational in that it can be used in an effort to arouse the student's interest in the lesson.

The title of this initiating activity is self-explanatory. The teacher who uses it provides the students with some reasons as to why they are studying the lesson. Now it seems likely that merely providing students with reasons for studying a particular topic will do little to enhance their learning if it is not clear to them what they are expected to accomplish. Hence, it is important for the teacher when using this initiating activity to make clear to the students the goals of the lesson. The initiating activity of Stating Goals, therefore, is a natural concomitant of this activity.

Anyone who has taught for very long at all has probably been faced, at one time or another, with students (and perhaps parents!) seeking an answer to the question, "Why study this?". The teacher who uses this initiating activity will not be caught off guard (sometimes embarrassingly!) by such queries. In all candor, however, it must be admitted that finding important reasons for studying a certain topic is often not an easy task.

Rationale. To work aimlessly at any task, that is, to work at a task without having a sense of direction or purpose in what one is doing, soon leads most people to a state of futility and frustration. Hence, the major rationale for the use of this initiating activity is that it can provide, for both the student and teacher, that sense of direction and purpose that can lead to a feeling of satisfaction in one's work. That is, it attempts to show the learner the value of what he is studying. Providing students with reasons that are meaningful and relatable to them for studying a particular topic can thus stimulate them and thereby enhance their learning. The real challenge to the dedicated teacher, of course, comes in trying to find the reasons for studying a particular topic or course that are meaningful and relatable to their students.

In high school, where most of the mathematics taught is of an abstract nature, Smith's (1968) comments on "Knowledge About Relevance and Uses of Subject Matter [p. 130]" are appropriate,

> As the subject matter of instruction moves away from the fundamental skills and into abstract content, the pupil is apt to become more concerned about the usefulness of the content he is studying. . . .
>
> While there may be no definitive answer to the pupil's concern about the utility of abstract subject matter, it is valuable for the teacher to understand the ways in which such content is used. These explanations will, of course, not allay the suspicions of some students but they will be useful to the teacher in relating the content of instruction to the lives of his students [Smith, 1968, p. 131].

Wilder (1970) seems to be supporting Smith's viewpoint when he writes:

> One of the most disturbing questions for the beginning teacher is 'What good is this?'--usually asked by a student who is determined not to waste time studying topics of no apparent use to him. . . . But the student has a right to an explanation--today he may demand it! In such situations the teacher's best defense is his own knowledge and appreciation of the position of the questioned topic in the over-all development of the subject [p. 8].

As Willoughby (1967) puts it:

> . . . When teachers are no longer asked by others, 'Why do you teach this subject?', they often forget to ask it of themselves. And if a teacher cannot answer that question, at least to his own satisfaction, there is some doubt whether his teaching is good enough to be worth the time and effort of the pupils [p. 60].

Willoughby, like Smith, however, concedes that there are no neat, simple answers to the "Why?" question for every topic and course in mathematics. We find him saying that:

> A good teacher will probably go on thinking about [this question] . . . and many others . . . for as long as he continues to teach without ever reaching a final answer. It is hoped that he will continue to revise his answers and try new ways of achieving new goals throughout his career [Willoughby, 1967, p. 59].

Since pat answers are not available to the "Why?" question, teachers who are interested in obtaining such answers must do some searching on their own. In doing this, they hopefully will arrive at some answers which will be satisfying to them and their students (and the students' parents). Many articles have been written that can help in formulating an answer to the question, "Why do we teach mathematics?". Just a few of these are listed below. All of the references listed are from The mathematics teacher. Others can be found in the National Council of Teachers of Mathematics Cumulative index of The mathematics teacher (N.C.T.M., 1967, pp. 171-175).

Some values of the study of mathematics, January 1931, 24, 46-51.

What permanent values have courses in mathematics for students who will make no professional use of them?, November, 1951, 44, 449-454.

Why mathematics?, May 1942, 35, 203-204.

Why study mathematics?, December 1931, 24, 473-482, February 1946, 39, 51-58.

Why teach mathematics?, April 1942, 35, 169-174, February 1945, 38, 51-55.

Mathematics--Its role today, November 1950, 43, 313-317.

Objectives in teaching of mathematics in secondary schools, February 1923, 16, 65-77.

What are the mathematical needs of the high school student?, February 1949, 42, 75-78.

Examples. Probably the most commonly used method of providing students with reasons for studying a certain topic is to offer a grade. For example, it is not uncommon to find teachers saying something like "You better learn how to use the quadratic formula because it is going to be included on your test on Friday." or "If you want to do well on the quiz, you had better learn how to find the volume of a regular hexagonal pyramid."

Other reasons that may be given for studying a particular topic may not have any bearing on the student's grade. In attempting to answer a parent's or student's question as to why study sets in mathematics, for example, a teacher might respond that the results of a study indicate that

> . . . It is possible that the students involved with sets have a better basic understanding, will have greater residual knowledge ten years hence, and will have a finer appreciation of the nature of mathematics than their traditional colleagues [Sueltz, 1961, p. 10].

Or, on another occasion, a teacher might tell his students, "By studying other numeration systems (such as the Roman and Egyptian) we hope to gain greater respect and appreciation for the compactness and simplification of notation of the numeration system we are used to working with."

The following dialogue contains some examples of why students take algebra in high school. Notice in this case that the teacher is encouraging the students to come up with some reasons for studying algebra.

Teacher: This being the first meeting of our algebra I class, I am interested in the reasons why some of you are taking this course.

Student 1: I intend to go to college, and my counselor told me that this course would help me meet entrance requirements.

Teacher: Okay, anyone else?

Student 2: I want to be an aeronautical engineer, and I know from talking to people that engineers need a good background in math.

Teacher: Is there anyone who does not plan on college immediately after graduating from high school? If so, why are you taking this course?

Student 3: I just plan to be a housewife and mother, and I am taking this course so that maybe I will be able to help my kids with their homework someday if they take algebra

Teacher: Truly an altruistic motive!

Student 4: I am taking algebra because I like math. (Several other members of the class groan!)

The final example which provides students with reasons for studying a particular topic or course may be called exhortation. Here the teacher attempts to influence the student's purpose in studying a topic merely by urging him to learn it because he (the teacher) feels it is worthwhile. An example is a teacher who might spend several days of class time in having the students make cardboard models of various polyhedrons. Responding to a student's query of "Why do we have to make these things?", the teacher replies, "Just please try hard, and do your best. I think that making these models is very satisfying and a lot of fun." Notice that the teacher offers very little reason for studying the topic other than his own opinion as to why it is important.

Presenting a Problematical Situation

Commentary. This activity is viewed largely as a motivational technique. It is used to gain the student's attention or to arouse his interest in the lesson. In this initiating activity, the teacher presents the students with a problematical situation. This might be done in several different ways. For example, the instructor might simply pose a question whose answer will depend in some way upon the content of the lesson. Another way of using this activity is to present the class with a paradoxical state of affairs. While the use of this activity is relatively simple and straightforward, more atypical uses of it can challenge most teachers' creativity. It should be understood that the problematical situation is to be more than just a question posed at the beginning of the lesson and then immediately answered. The intent in this initiating activity is that the problem will serve as sort of a theme around which the teacher presents the new material.

Rationale. The rationale for this initiating activity rests largely on the fact that most human beings are curious. By posing some sort of problematical situation related to the new learning material, the teacher attempts to capitalize on the student's "natural" curiosity. He hopes they will ask such questions as "Why does this happen?", "How can that be explained?" or "Where is the flaw?". By thus arousing their interests, the students will, presumably, be more receptive to presentation of the lesson.

Several writers seem to advocate such an initiating activity. Rosenberg (1970) feels that "Methods of instruction that challenge a student or appeal to his curiosity are likely to stir his interest [p. 151]." "Interesting and unusual problems," writes Sobel (1970), "can be used to create excitement and enthusiasm for a topic [p. 306]." He then illustrates how mathematics teachers who are beginning to teach skills regarding limits and infinite series might begin their discussions with thought provoking questions such as:

> How many pennies are there in a pound of pennies? How much would one million pennies weigh? How high a pile would one million pennies make? Can one million basketballs fit into this classroom? What about one million Ping-Pong balls? One million marbles? One million pennies?
>
> After this exploration of concepts of the large but finite, the teacher can turn the attention of the class to the infinite with the problem of the infinite tree . . .
>
> The tree grows one foot the first day. Then on the second day, 2 branches appear at right angles to each other and each grows 1/2 foot [see Figure 5]. The third day 2 new branches grow 1/4 foot from each stem. This growth process continues forever.
>
> . . . The student [may then be asked to] search for discoveries concerning the number of branches in the tree, the limiting height and width of the tree, and so forth [Sobel, 1970, pp. 306-307].

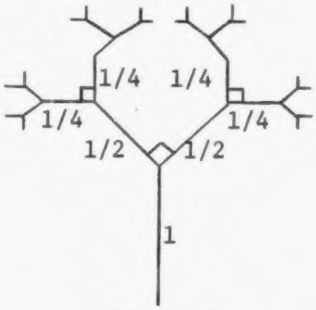


Figure 5

Suchman (1961, 1962) also sees merit in using such an initiating activity. In his efforts to develop inquiry skills in sixth graders, he uses films to present an initial problem episode to the students.

> The film is used simply to present a clear picture of a physical event and to pose a question about its causation. It is over almost at the point where most instructional films begin. It does not teach, nor does it usurp the autonomy of the learner. It prompts activity on the part of the learner and gives some direction to that activity. It marks out an area for investigation and generally motivates the learner to find an explanation. . . . the information given in the film . . . _is_ enough to puzzle the learner and arouse his curiosity. The inquiry films are designed to disequilibrate the learner by presenting discrepant events that he cannot fully explain and/or could not have predicted [Suchman, 1962, p. 51].

Additional support for the use of this initiating activity in the mathematics classroom can be gleaned from Polya's (1957) book, _How to solve it_. While Polya is interested in problem solving from more than just an initiating activity standpoint, his confidence in the posing of a problematical situation to students as a means of arousing their interest is suggested by the following quotation:

> . . . a teacher of mathematics has a great opportunity. If he fills his allotted time with drilling his students in routine operations he kills their interest . . . But if he challenges the curiosity of his students by setting them problems proportionate to their knowledge, and helps them to solve their problems with stimulating questions, he may give them a taste for, and some means of, independent thinking [p. v].

Berlyne (1965) uses the term "epistemic behavior" to refer to those activities whose function is to build up knowledge. Such activities include "thinking, rehearsing to oneself symbolic responses copied from teachers, asking questions, and observing [p. 77]." "Epistemic curiosity, the motivational condition making for epistemic behavior," according to Berlyne, "apparently results from _conceptual conflict_, which means conflict due to discrepant thoughts or beliefs or attitudes [p. 77]." In his paper, he lists five ways in which epistemic curiosity can be induced through conceptual conflict. The five ways are surprise, doubt, perplexity, bafflement and contradiction.

Berlyne's (1965) discussion of "doubt" is especially appropriate for the initiating activity presently under discussion. He says,

> . . . Doubt, i.e., conflict between tendencies to believe and disbelieve, is put to good use in some of the new mathematics curricula. I once had the privilege of witnessing a sample lesson given by Dr. David L. Page under the auspices of the University of Illinois Arithmetic Project, in which third-grade children were being introduced to the fact that the difference between the squares of two adjacent integers [i.e., $(n + 1)^2 - n^2$] is always an odd number. On another occasion, I heard a lecture by Professor G. Polya, describing how, using essentially the same method as Dr. Page, he would teach Euler's theorem (that $R - E + V = 2$, where R, E, and V are, respectively, the numbers of faces, edges, and vertices of a polyhedron).
>
> Both lessons began by showing the principle to hold true for one specific case after another. As it was confirmed with each example, the question of whether it would work for the next example was raised and the corresponding curiosity induced. Once enough examples had been given to make the universal validity of the principle seem credible, a different sort of conflict was introduced by asking whether the principle must always hold true and why. In this way, the pupils were motivationally prepared for the equivalent of a proof [p. 79].

If questions which precede verbal learning have the same effect as questions that precede written learning passages, then it behooves teachers, who use this initiating activity, to be aware of the specific facilitative effect on learning and retention that studies by Rothkopf (1966) and Frase (1967, 1968a, 1968b) suggest that such questions have. Under the above assumption, teachers are well advised to select carefully those questions used to initiate lessons. It would seem that those questions whose answers involve the most important elements of the new learning material are to be preferred.

Nietling (1968) was influenced by Polya and others who feel that problems presented before classroom study of a related topic can promote student learning and discovery. Hence, Nietling's investigation involved an attempt to examine the effects on pre-classroom learning that such problems might have. Although he admits some disappointment in his results with lower division college students, Nietling does conclude that the problems did stimulate out-of-class student searches and explorations on the mathematical topics related to the initiating problems. He also concluded no significant difference in the learning of mathematics between the group exposed to the problems and the group which was not. Further results of a student opinion survey failed to indicate any significant difference in attitude, interest or morale between the control and exploratory group.

Examples. Some further illustrations of the use of this activity are given below.

Example One

> Suppose that the goal in a particular algebra II lesson is to know how to find the resultant of two vectors. One might initiate this lesson by displaying a force table (borrowed from the physics laboratory) having two weight pans loaded. The teacher might then pose the question, "Where would we have to position the third weight pan, and how heavy would it have to be in order to 'balance' these other two weights?" After a few trials by the students, the teacher might show how such a problem can be handled mathematically.

Example Two

Suppose that in a geometry class, the teacher goes through (at the board) the following sequence of constructions:

a. There exists a unique line m in the plane E containing P and perpendicular to ℓ.

b. There exists a unique line n in E containing P and perpendicular to m.

c. Therefore $n \parallel \ell$.

d. From any point R (different from P) on n there exists a unique line RS perpendicular to ℓ at S.

e. There exists a unique line from P intersecting line RS at a point Z such that $\overline{PZ} \perp \overline{RS}$. (Anderson, 1966, p. 285)

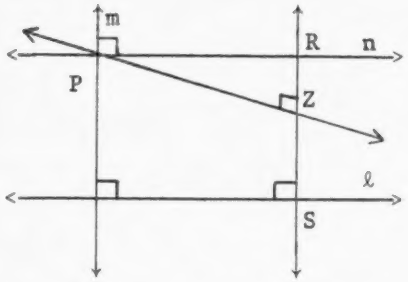


Figure 6

The teacher might then either point out or elicit from the students the seemingly embarrassing situation, namely, that line n and line PZ are both parallel to ℓ and yet pass through P. Such a problematical situation could serve as the starting point of a discussion of non-Euclidean geometries. All of the above would precede the introduction of the parallel postulate which would be the main learning goal of the day. In this example, one also can see an excellent opportunity to make use of a historical initiating activity.

Example Three

Let us imagine that we wish to teach students the geometrical interpretation of the Pythagorean theorem. The teacher could begin by placing the following transparencies on the overhead projector (see Figure 7); then asking the question: "What appears to be true concerning the areas of (a) the three triangles, (b) the three circles, (c) the three pentagons, etc. Eventually, the correct relationship between the areas of the squares drawn on the sides of a right triangle could be obtained, and, if desirable, a proof could be given.

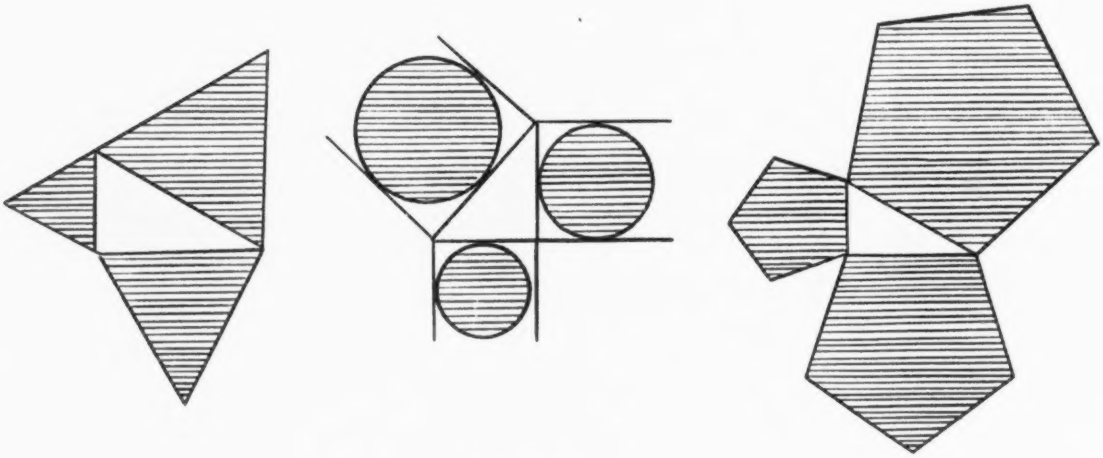


Figure 7

This chapter has provided the reader with some rather detailed information regarding the seven initiating activities (Stating Goals, Outlining, Using an Analogue, Using Historical Material, Reviewing Subordinate Information, Giving Reasons and Presenting a Problematical Situation) that were identified in this investigation. Some general comments relating to these activities were given on page 20, and, in addition, written examples illustrating each activity were presented.

CHAPTER THREE

THE ILLUSTRATIVE MATERIALS

How Materials Were Obtained

Although studio facilities exist at the University of Illinois for producing video-tapes, it was decided that all taping would be done in actual classroom situations. Such a decision was made primarily on the assumption that video-tapes of real teachers in real classrooms with actual high school students would be of much greater interest to pre-service teachers (with whom these materials were to be used) than would tapes of artificial situations acted out in a television studio with paid students.

This decision brought with it the burden of finding a school (or schools) and a group of mathematics teachers who would be willing to cooperate in the project. Since the University of Illinois was involved with School District 214 (Arlington Heights, Illinois) in an experimental student teaching program, a logical first step was to see if any of District 214's six high schools were interested. A letter of inquiry resulted in Wheeling High School's mathematics department agreeing to participate. The school has an enrollment of approximately 2,800 students and a full-time mathematics department of fifteen teachers, thirteen of whom actually participated in the video-taping. In addition, three other mathematics teachers from a neighboring school (Glenbrook South High School in Glenview, Illinois) agreed to participate.

About five weeks (distributed over a three month period) were spent at Wheeling. The greatest portion of this time was used in working with the teachers in planning their lessons so that certain initiating activities would be evident in the presentations to be taped. The usual procedure in preparing for video-taping a class was to determine what specific topic was going to be taught on a certain day. Having this information, the teacher and the investigator would then examine the list of initiating activities in an effort to ascertain which would lend themselves especially well to the topic and ability level being taught. Such preplanning was desirable for two reasons. First, it expedited the acquisition of examples of all the initiating activities in the time available. Secondly, it avoided using an excessive amount of videotape. By knowing what initiating activities were going to be used in a certain class, it was possible to record only small portions of the lessons. It should be emphasized that this preplanning was not tantamount to staging classroom incidents. At no time during the taping sessions were the students instructed to respond in any particular way. As a matter of fact, the students were unaware of the specific nature of the project. In addition, none of the instructors shown used any sort of script. One or two did, however, make use of notes to help remind them of the activities they were going to use.

The actual recording of the classes was done using the equipment listed in Appendix A. In all tapings, the camera and video-tape recorder (VTR) were positioned at the side of the room. This permitted viewing the faces of both the teacher and the students. Sound recording was done three different ways (see the figures in Appendix A): (a) using two floor microphones (unidirectional) placed toward the front of the classroom about eight feet apart and both directed toward the teacher;

(b) using one lavalier microphone around the teacher's neck; (c) using four unidirectional microphones suspended from the ceiling. The microphones described a rectangle with dimensions of approximately five feet by eight feet. Two were directed toward the teacher and two toward the class. Most of the recording was done using arrangements (a) and (c) with configuration (c) producing the best all-around results.

After taping the various teachers who were attempting to illustrate different initiating activities, the tapes were viewed by both the investigator and the teacher. During these follow-up sessions, the instructors made comments on their presentations and also cleared up any questions the investigator had concerning what was occurring in the class. At this time, the teachers also filled out a video-tape identification form like the one shown in Appendix B.

Following the collection of the video-tapes, it was necessary for the investigator to view each of them several times in order to decide precisely what portion of each clip would be kept for final copy. The tapes were carefully analyzed and the initiating activities were classified and summarized as illustrated in Tables 2 and 3. An instructor in educational psychology at the University of Illinois also viewed each of the video-tapes. She made quite a number of comments concerning psychological principles that were (or failed to be) employed by the teachers shown in the clips. Some of these comments were quite helpful to the investigator in formulating the questions concerning what was happening in each of the twenty clips.

Table 2

Location of the Initiating Activities in the Clips

Initiating activity	Clip number where activities are found
1. Stating Goals	1, 3, 4, 5, 7, 8, 14, 15, 18, 19
2. Outlining	4, 5, 8, 10, 13
3. Using an Analogue	17
4. Using Historical Material	6, 10, 12, 18, 20
5. Reviewing Subordinate Information	1, 4, 7, 11, 13, 14, 16, 20
6. Giving Reasons	1, 2, 3, 4, 8, 9, 19, 20
7. Presenting a Problematical Situation	2, 3, 11, 12, 14, 15, 16, 20

Table 3

The Twenty Video-tape Clips

Clip number	Running time	Location	Initiating activities being attempted
1	8 minutes	T1 0-129	1, 5, 6
2	6-1/2 minutes	T1 137-219	6, 7
3	10-3/4 minutes	T1 221-345	1, 6, 7
4	6 minutes	T1 346-410	1, 2, 5, 6
5	4-3/4 minutes	T1 412-459	1, 2
6	8 minutes	T1 461-535	4
7	8 minutes	T1 537-605	1, 5
8	3-1/2 minutes	T1 607-637	1, 2, 6
9	10-3/4 minutes	T2 12-164	6
10	23 minutes	T2 166-427	2, 4
11	12 minutes	T2 428-540	5, 7
12	11-1/2 minutes	T2 542-640	4, 7
13	13 minutes	T3 12-206	2, 5
14	5-3/4 minutes	T3 208-270	1, 5, 7
15	3-1/2 minutes	T3 272-312	1, 7
16	5 minutes	T3 314-369	5, 7
17	15 minutes	T3 316-517	3
18	15 minutes	T3 519-651	1, 4
19	3-1/2 minutes	T3 end	4, 6, 7
20	9 minutes	TTT 17	5, 6

Summaries of the Materials

A few comments are in order concerning the organization of this section. This section contains brief descriptions of each of the twenty video-tape clips collected in this thesis along with some discussion questions related to each. In addition, an edited transcript of each clip is included with the various initiating activities highlighted by an arrowhead (◁) containing the number of the activity being attempted according to the following numerical scheme: 1--Stating Goals, 2--Outlining, 3--Using an Analogue, 4--Using Historical Material, 5--Reviewing Subordinate Information, 6--Giving Reasons, and 7--Presenting a Problematical Situation. For example, the symbol "◁ 1" occurring in a transcript would indicate a point where the teacher had stated a goal of the lesson.

The ordering of the video-tapes presented in this section is arbitrary. Another way of arranging the video-tape materials is suggested by Table 2. In such an arrangement, ten different teachers could have been grouped together to form the first clip entitled "Stating Goals." Using this scheme, the viewer would see the ten teachers making utterances classified as stating goals. The next clip would show five teachers outlining, etc. The decision not to arrange the clips this way is based upon several considerations. First, to do this would mean, in some cases, removing the initiating activities from their context which, to this investigator, seemed undesirable. For example, it seems likely that the mere viewing of ten different teachers stating goals is not going to be as interesting or as conducive to discussion as is the viewing of a teacher stating the goals of a lesson along with some of the incidents surrounding the use of the initiating activity. Closely allied to this is the almost certain reduction in versatility that such an arrangement would have. For although their intended use is for discussing initiating activities, there is certainly no reason why other aspects of the teaching illustrated can not be focused upon. Fragmenting the tapes, as suggested above, would surely reduce potential discussion topics.

CLIP 1 RUNNING TIME: 8 MINUTES CLIP LOCATION: T1 0-129

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals, Reviewing Subordinate Information, and Giving Reasons

SUMMARY OF CLIP 1

In this clip we see a male teacher with 14 years of teaching experience teaching an algebra I class of somewhat above average students. The teacher's goal is to teach the students how to solve simple linear inequalities. Very little of the students is shown in this clip.

Several initiating activities are being attempted in this clip. The first is a statement of the goal of the lesson which is the first thing that the teacher does. ["Today we're going to introduce the idea of inequalities."] We next see the teacher attempting to provide the students with some reasons why they are going to study inequalities. He does this by pointing out a number of places in life where unequal situations exist, for example, people's weights, shoe sizes, arm lengths, etc. He then says, "So conditions of inequalities in our lives are things that we have to learn to adjust to and to work with." In the last portion of the clip, the teacher uses a third initiating activity by engaging in a review of some of the properties of equality and inequality that the class has studied, but that will be of importance in the new work, i.e., solving linear inequalities.

QUESTIONS FOR DISCUSSION

1. What is your reaction to the statement of the goal by the teacher? Comment.
2. Give some suggestions as to how the instructor might have strengthened his reasons for studying inequalities.

3. Do you feel that the review of subordinate information attempted by this teacher was justified? Why or why not?

4. What was your impression of the students' responses to the review? Can you think of any ways of improving the instructor's attempt to review subordinate information? Give some suggestions.

5. What do you find most commendable about this teacher's use of initiating activities?

6. How would you have initiated the study of this topic?

7. In addition to the reasons for studying the material that are mentioned in the above summary, the teacher early in the lesson gives the class another reason. What is this reason? Can you think of any adverse effects of using such a reason?

TRANSCRIPT OF CLIP 1

T: We've been working on word problems, but now today we're going to introduce the idea of inequalities. Now this is one of our sections 1 that we have to cover in our textbook. Now one reason for studying inequalities is, of course, the fact that there are so few things that we encounter in our everyday lives that are equal. Mike is heavier than Laurie is. He's got black hair and she's got red hair. One has a bigger size shoe than the other. I imagine if we were 6 to look in here and measure your feet accurately, probably there would be no pair that were equal. Your arm lengths are always different. So we're not really equal in many instances. Even if you have somebody arrest you for the same offense, some people get a harder sentence than others. So conditions of inequalities in our lives are things that we have to learn to adjust to and to work with.

So far in our course, we have learned how to work with quantities that are equal. Now we will consider unequal quantities. For instance, if we have a sentence like this, $2x + 3 = 5$, we could convert this equality into an inequality such as $2x + 3 > 5$ or $2x + 3 < 5$. These are examples of inequalities that we frequently 5 encounter and must be able to solve. So how can we go about solving such inequalities?

As a review, remember that we have studied properties of equality and inequality. For example, we talked about the addition property of equality and the multiplication property of equality when we said that, If $a = b$, then $a + c = b + c$. In other words, you may add the same thing to both sides of an equation. That's our addition property of equality.

The multiplication property of equality is, If $a = b$, then $ac = bc$. Now these are properties of equality. Now for inequality, some things change a little bit as we'll see in a minute. We also studied the transitive property of equality. It goes like this, If $a = b$ and $b = c$, then $a = c$. For inequalities, it would be, If $a > b$ and $b > c$, the $a > c$. We could also express it as, If $a < b$ and $b < c$, then $a < c$.

Going back to the addition property of inequality, we would have, If $a > b$, then $a + c \quad b + c$. Does this work when we use numbers? If $5 > 4$, is $5 + 3 \quad 4 + 3$? Yes. For multiplication, we must be a bit more careful depending upon whether our value of c is positive or negative. For example, If $5 > 4$, then $5 \cdot 3 \quad 4 \cdot 3$ or $15 > 12$. But now, if c is negative, we have $5 > 4$ and $5 (-4)$ will be less than $4 (-4)$. So we see that when we multiply an inequality by a negative number, the sense of the inequality will change. That is, -20 will be to the left of -16 on a number line, and, hence, will be less. These then are the properties of equality and inequality of addition and multiplication as well as the transitive property that will be employed when solving inequalities. Now to show how we make use of these properties in actually solving inequalities, let's consider the following: [At this point, the teacher goes through several examples of how one solves inequalities.]

CLIP 2 RUNNING TIME: 6-1/2 MINUTES CLIP LOCATION: T1 130-219

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Giving Reasons and Presenting a Problematical Situation

SUMMARY OF CLIP 2

In this clip, we see a male teacher with one year of teaching experience working with a class of below-average students in a first year algebra course. The teacher's goal is to show students how factoring can be used in working with fractions.

The teacher is attempting to use two initiating activities. A couple of times during the class, the teacher tries to give the students some reasons for studying the new material, factoring. He tells them that knowing how to factor is important for knowing how to reduce fractions. He also attempts to pose a problematical situation by asking the students why 2/4 = 1/2 and 1/2 + 1/3 = 5/6.

QUESTIONS FOR DISCUSSION

1. Locate the portions of the clip where you think the teacher is using each of the initiating activities. Do you feel that the instructor was successful in his use of the activities? Tell why or why not.
2. Name something you especially liked about this teacher's presentation. Tell why you liked it.
3. Describe something that you did not like about this teacher's presentation. If appropriate, tell how he might have improved it.
4. At one point in this clip, the teacher used sarcasm. This occurs when he says something like "Now I know you all love fractions!" Discuss some possible positive and negative effects that such a statement might have on students.
5. What suggestions would you give to this teacher for improving his initiating activity, Presenting a Problematical Situation?

TRANSCRIPT OF CLIP 2

T: What I want to do now is to take a look at the whole Chapter 4.
Leaf through it right now and look at everything in it. I think
you'll notice that it has mainly to do with fractions. Now I know
everyone in here loves fractions! You might find, however, that
as we work through this chapter, they'll be a little easier than
you had anticipated from your previous work. I know that in the
past a lot of you have had trouble with fractions. This chapter
is designed so that you'll have an easier time with them if you 6
follow certain directions. If you add fractions a certain way,
and if you multiply fractions a certain way.

The whole chapter has to do with things like this: Why is 2/4 =
1/2? Is 2/4 = 1/2? Well, I think everybody in here will agree
that that is true, 2/4 does equal 1/2. 100/200. Does this fraction 7
equal to 1/2? Well, again, I think everybody here will agree
that it does, but WHY does it equal to 1/2?

S: Because you can reduce it.

T: Ok, you say we can reduce it. This chapter will show us why
exactly this equals 1/2. Why does 1/2 + 1/3 = 5/6? Now this is 7
a little different problem. This chapter will help us to answer

> this "Why?" question. In order to obtain answers to the problems posed, we have to be able to do something with numbers called factoring. We use factoring in every one of these problems. This whole chapter has to do with factoring. That's the big word in this chapter, factoring. You must be able to factor. How many of you have studied factoring before? About one-half of you. You might have had it before without realizing what you were doing was called factoring. Let's take a look at a few examples and see just what factoring is. [At this point, the teacher works through a simple problem showing, by use of factoring, why 2/4 = 1/2. He also gives some more difficult examples of what factoring is.]

CLIP 3 RUNNING TIME: 10-3/4 MINUTES CLIP LOCATION: T1 221-345

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Giving Reasons and Presenting a Problematical Situation

SUMMARY OF CLIP 3

In this clip we see a female teacher with seven years of experience instructing a class of above average juniors in a second year algebra course. The teacher's long-range goal is to teach the class how to simplify radicals. Her specific goals for this lesson are to have the students recognize when a radical is not in simplest form and also to be able to use the product and quotient properties of radicals to simplify them.

The teacher is attempting to use three initiating activities. All appear early in the lesson. A stating of the goal occurs when she says "Today what we will be interested in primarily is looking at the ways in which we simplify radicals." Immediately following this statement, the teacher provides the students with a reason for studying how to simplify radicals, namely, because the technique will be necessary in deriving the quadratic formula later in the course. The third initiating activity is a problematical situation. It comes when the teacher writes the four unsimplified radicals on the board.

QUESTIONS FOR DISCUSSION

1. Keeping in mind the time of day this class met (8 a.m.), how would you as the teacher have modified the "opening ceremonies"?

2. Do you feel that the teacher did an adequate job of stating the goals of the lesson? If not, how would you improve it?

3. The instructor gave as one reason for learning how to simplify radicals that it is necessary in deriving the quadratic formula. Can you think of other reasons? List them.

4. Find two things in this clip which you especially liked. Describe two things about the teaching that you did not like and tell how you would improve them.

5. What was your overall reaction to the class? Give reasons for feeling as you do.

TRANSCRIPT OF CLIP 3

T: May I have everybody's attention please. In the first few sections
of this chapter, which we rather hurriedly went through, we were
introduced to a more in-depth view of irrational numbers. Now
we are particularly interested in those denoted by a radical symbol
such as $\sqrt{2}$, $\sqrt{7}$ and so on. These are the ones we are particularly
interested in even though we did view some of the irrational
numbers that are denoted by decimals. Okay, well today what we
will be interested in primarily is looking at the ways in which 1
we simplify radicals. Now one of the reasons that we're interested
in simplifying radicals is that it will enable us to derive a
formula for the solution of quadratic equations. We have to know 6
how to simplify radicals so that that formula may be derived. In
first year algebra, you probably saw the formula, but you never
derived it. This year we will be deriving this formula and for
that purpose the simplification of radicals is necessary.

Okay, let's take a look at a few radicals that will require simplification. I'm going to list them at the side just so we see 7
what we will be talking about eventually. [At this point the
teacher lists four examples of radicals requiring simplification.]

$\sqrt[3]{32a^6}$ $6/\sqrt{2}$ $\sqrt{7r^2/12}$ $\sqrt[3]{1/20a^4}$

Okay, now there we have four examples of radicals that will require simplification. One of the things we're going to have to see first of all is why they are not simplified, and, if they're not simplified, what do we do about it and how. We'll leave those for just a moment, however, and we're going to have to see also some of the properties that are suggested, some of the theorems that we will be using as we attempt to simplify those radicals. Let's take a look at a few examples. Here we see the cube root of a product. [For the next 3 or 4 minutes, the teacher explains to the class three laws of exponents (viz., $\sqrt[n]{ab} = \sqrt[n]{a}\,\sqrt[n]{b}$; $\sqrt[n]{a^m} = (\sqrt[n]{a})^m$; $\sqrt[n]{a/b} = \sqrt[n]{a}/\sqrt[n]{b}$). She gives numerical examples of each and points out that these properties will be used in later work with radicals.]

Would you take a look at the top of page 326 please. We see a list of 12 problems. Would you just take a quick look at those to see if there are any questions with regard to the application of the product property and the special property that we derived over at the right. [Pause] Let's just quickly take a look at one of these and see if someone could give us the result. What about the $\sqrt[4]{8}\,\sqrt[4]{2}$? How else might that be written if we apply the product property. Jim? [The teacher spends the rest of the class period discussing four rules under which a radical is said to be in simplest form.]

CLIP 4 RUNNING TIME: 6 MINUTES CLIP LOCATION: T1 346-410

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals, Outlining, Reviewing Subordinate Information, and Giving Reasons

SUMMARY OF CLIP 4

This clip shows a male teacher with one-half year of teaching experience. He is working with a class of sophomores and juniors in a below average geometry class. Usually students will spend one year in a high school geometry course. The pupils in this clip, however, will take two years to study the same course. They are in the first semester of their first year of study. The teacher's goal is to teach the students what angle bisectors are as well as the meaning of the Angle Bisector Theorem which says, For every angle, there is exactly one bisector.

The teacher is attempting to use four initiating activities. They are Stating Goals, Reviewing Subordinate Information, Outlining and Giving Reasons. The initiating activities of Stating Goals and Outlining are very closely related in this clip. In fact, what the teacher does is to present the goals of the lesson as a four-point outline.

QUESTIONS FOR DISCUSSION

1. Identify where the teacher used each of the four initiating activities. Do you feel that the teacher's selection of initiating activities is appropriate for the general ability level of the class? Explain.
2. What reason does the teacher give to help justify studying the new material? Do you feel that this is a good reason? Tell why. Can you think of some other reasons for studying the material? List them.
3. Commenting on his performance after being taped, this teacher said he didn't feel his presentation was very good. Can you spot any possible reasons for his feeling this way? Make references to the video-tape.
4. Describe briefly how you would teach this topic to a class of the same ability level.

TRANSCRIPT OF CLIP 4

T: First of all, does everyone have an assignment sheet and a proof sheet? Okay. Last night, you should have read the next section that we're going to cover talking about the Angle Bisector Theorem. On the board is a short outline of this section. [The teacher has written on the board the following outline:

I. Definition of angle bisector
II. Angle Bisector Theorem
III. Definition of median of a triangle
IV. Definition of angle bisector of a trinagle.]

1
2

First, we're going to deal with the definition, that is, what is an angle bisector. Secondly, we will discuss the angle bisector theorem. Next, we will talk about what is meant by the median of a triangle; finally, what is meant by the angle bisector of a triangle.

The purpose of what we're studying is that when we're through we 6
will hopefully be able to incorporate all of these ideas into
our methods of proving additional and more difficult theorems in
geometry. So we'll be able to add this to, for example, our
isosceles triangle theorem that we covered in the last section
and our theorems dealing with perpendiculars, etc. Okay, first 5
of all, Barb, what's an angle? [At this point, the teacher launches
into a discussion of the items to be covered in the lesson outline.]

CLIP 5 RUNNING TIME: 5 MINUTES CLIP LOCATION: T1 412-459

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals and Outlining

SUMMARY OF CLIP 5

This clip shows a male teacher with three years of teaching experience working with a class of accelerated freshmen in a second year algebra course. The teacher's ultimate goal in the lesson is to have the students learn how to graph the equation of any ellipse in standard form.

The teacher has chosen two initiating activities to use. Both are obvious. The teacher presents the goal of the lesson in written form, via an overhead projector. He also uses a four point outline covering the major facets of the lesson. These too are written on a transparency, and the four points are uncovered one at a time as the instructor reads them to the class.

QUESTIONS FOR DISCUSSION

1. Was the instructor successful in using the initiating activity Stating Goals? That is, do you think that the students really knew what they were going to be expected to know at the end of the period? Tell why or why not. Do you see any benefits for the students or the teacher in writing out the goal of the lesson as was done in this clip? Explain your answer.

2. What might the instructor have done in an attempt to heighten the student's interest in the study of ellipses? Be specific.

3. Describe what you feel to be the student's reaction to the teacher's introduction. Cite evidence from the video-tape to corroborate your feeling.

4. What do you see as the major benefit of the small-talk dealing with basketball games that occurred in this clip prior to the beginning of the class?

TRANSCRIPT OF CLIP 5

T: What we're going to talk about today is the sllipse. This is the
third of the conic sections. First, we dealt with the circle;
then the parablola. Now we're going to talk about the sllipse. 1
The goal of our lesson today is to familiarize you with the ellipse,
to state its definition and to learn how to graph the ellipse.
An outline of what we're going to do today consists of the following: [The teacher has the items below on a transparency:

I. Define the ellipse.
II. State a general equation for the ellipse. 2
III. Discuss the properties of the graph of the ellipse.
IV. Learn how to graph the ellipse making use of some of the properties in point three.

The teacher then begins going through the points of the outline making use of the overhead projector.]

CLIP 6 RUNNING TIME: 8 MINUTES CLIP LOCATION: T1 461-535

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Using Historical Material

SUMMARY OF CLIP 6

This clip illustrates a male teacher with seven years of experience teaching a mixed ability second-year algebra class of juniors and seniors. The class shown has been working on logarithms for several days. The goal of the lesson is to provide students with additional information and practice in computing with logarithms.

The primary initiating activity the teacher is attempting is Using Historical Material. The models of Napier's Bones and how they are used are intended to give students some historical information about the man who is credited with the invention of what they are studying, namely, logarithms. In addition, although Napier's Rods per se have no relevance to logarithms, the instructor hopes that the use of this initiating activity will provide some motivation for the continued study of logs.

QUESTIONS FOR DISCUSSION

1. Do you feel that the use of this initiating activity is appropriate even though the class has been studying logarithms for several days? Why or why not?
2. Aside from its use with a unit on logarithms, where else might this initiating activity be used? What modifications would be necessary?
3. Judging from the clip, do you feel that this initiating activity was effective in gaining the attention and arousing the interest of the students? Justify your answer.
4. How else might the instructor have used Napier's Bones to initiate the study of logarithms?
5. Can you think of any other initiating activities that might be appropriate for beginning the study of logarithms? Describe such activities.

TRANSCRIPT OF CLIP 6

T: [The class beings with the teacher displaying ten cardboard models of Napier's Bones.] When you came in the room, you saw all of these things. Can you think of anything we might use them for? 4

S: To help find logarithms.

T: No, they don't have any direct relation to logarithms.

S: Multiplication.

T: Right. They can be used to perform simple multiplications. They were invented way back in the 1500's. Now, how do you think these are constructed, that is, how are all of these numerals in each column obtained? [At this point the teacher gives several of the cardboard models to different students for closer examination.]

S: The numbers are multiples.

T: That's right. Each of the numbers is a multiple of one of the digits 0 through 9. We have ten cardboard rods, each with four faces, so each of our ten digits is represented four times. Notice, for example, on this face headed by a 2, we have underneath it its multiples, 2, 4, 6, 8, 10, 12, 14, 16 and 18. [See Figure 8.]

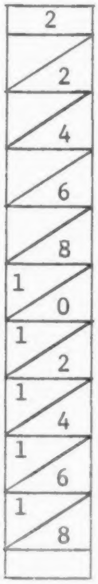


Figure 8

So very briefly then that's how the rods are constructed. Now to see how we can use these things to multiply, someone give me a 3-digit number.

S: 237

T: Okay, 237. Give me another 3-digit number.

S: 365

T: Okay, we're going to multiply 237 by 365. All right, the first thing we need to do is to find three rods--one headed by a 2, another one headed by a 3 and a third one headed by a 7. We then place these rods side by side. [See Figure 9.]

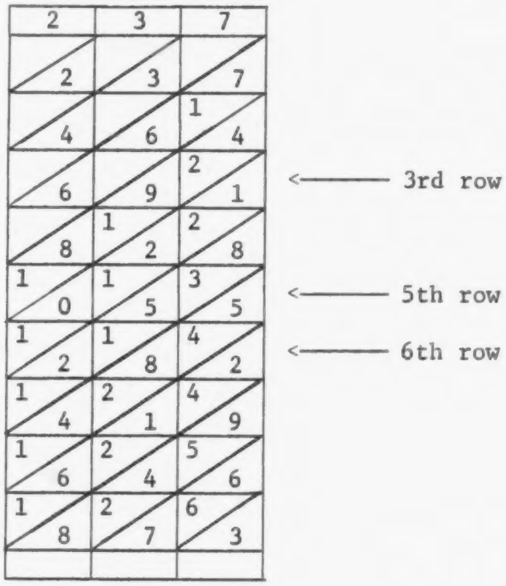


Figure 9

Now we're multiplying by 365. Well, we can only multiply by one digit at a time. Let's first multiply by 5. To do this, look at the rods, and come down to the fifth horizontal row of numbers and then just read across. We have 5; what would the next digit be then?

S: Eight.

T: Right, it would be 8, because we must add along the diagonals as we read across. So, we have 1185. Multiplying by 6 now, we come down to the sixth row and reading across we get 1422. And finally multiplying by 3, we get 711. [At this point, the teacher has the following display on the blackboard:]

```
  265
 1185
1422
711
```

Now, all we have to do is to add these numbers, and we have our desired product. So we get 86,505. Now the gentleman who invented these things was John Napier. He lived from 1550 to 1616 I believe. Not only did he invent these calculating rods, which by the way are sometimes called Napier's Bones or Napier's rods, but he is also credited with the discovery of logarithms. Now while these rods do not relate directly to logarithms, they may give you some idea of the type of thinking this man did go through. I might just mention in passing that in discovering logarithms, Napier related the movement of two points, one on a line segment of finite length and the other on a line segment of infinite length. He related these movements by geometric and arithmetic progressions. The development involves calculus, and so we cannot discuss it in this class.

Now although Napier's Bones may seem to us today to be a rather inefficient means of multiplying two numbers, in the 1500's, these things represented quite an advance in mechanical calculation. ... Are there any questions on any of this?

S: What do you do if you have a number like 233?

T: You mean where we have a digit repeated?

S: Yes.

T: This is the reason that we have each of the ten digits repeated four times on these ten rods. Having such duplications allows us to work with numbers where some digits are repeated.

CLIP 7 RUNNING TIME: 8 MINUTES CLIP LOCATION: T1 537-605

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals and Reviewing Subordinate Information

SUMMARY OF CLIP 7

In this clip, we see a male teacher with four years of experience conducting a large lecture group in geometry. The class is mostly sophomores of average ability. The teacher's goal for the lesson is to explain to the class the proofs of two theorems. Particular attention is to be given to the indirect method of proof of the second theorem.

There are two initiating activities being illustrated in this clip. The first is quite clear; it occurs when the teacher places the transparency containing the goal-thermometer on the overhead projector. On this transparency is written the lesson's goal, namely, to get all the people in the room to understand the two theorems to be presented.

The second initiating activity is a review of subordinate information. That is, the instructor spends a few minutes in reviewing three things. These are the Exterior Angle Theorem, the various ways of proving triangles congruent and how one proves something indirectly. The first and the third review items have direct relevance to the student's understanding of the proofs of the two new theorems.

QUESTIONS FOR DISCUSSION

1. Do you believe that the teacher's statement of the goal of the lesson was effective in informing the students as to what they would be expected to understand by the end of the class? Suggest improvements if you can.
2. What might the teacher have done toward the end of the class period (or perhaps at the beginning of the next class period) in an attempt to assess how effective he had been in achieving his goal?
3. When the teacher shown in this clip viewed himself in action, one of his comments was that he needed more life and enthusiasm in his presentation. Do you agree? If so, what suggestions would you give to him?
4. Do you feel that the instructor shown was wise in involving his audience in the review of the first two items that he reviewed, or would you have preferred that he conduct the review with no pupil participation? State some pros and cons of reviewing in each of these ways.
5. Are you in favor of lecturing to high school students? Discuss, briefly, some of the pros and cons of such a teaching technique at the secondary level.
6. Should the teacher in Reviewing Subordinate Information have spent time obtaining, from the students, the various ways of proving triangles congruent? Comment.

TRANSCRIPT OF CLIP 7

[The teacher begins the lecture by displaying an overlay on which has been drawn a theromometer with its mercury level to the 4 mark. Also on this overlay is written a statement of the teacher's goal.]

T: Today's goal, that is, what we're going to try to accomplish is
to get 68 people in the room to know two new theorems related to 1
inequalities in a single triangle. [The two theorems to which
the teacher is referring are: If two sides of a triangle are
unequal, then the angles which are opposite these sides are also
unequal and its converse.]

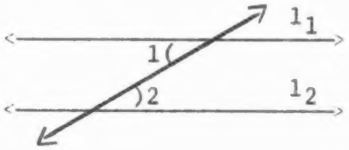
Right now, as you can see, the level of mercury in this goal thermometer is at the 4 mark. There are some teachers in here and perhaps a student or two who already understand the content, as well as the proof of these two theorems. What I want to accomplish by the end of the period is to get the goal thermometer's reading to the 68 mark which will include everyone in the room.

To achieve this goal, we must first go over a few items that we
have studied, and which will be useful for our understanding of
the two theorems today. For the first item, I would like to 5
have a volunteer to come up here and explain to us what the
Exterior Angle Theorem says. Does anybody want to volunteer?
[Pause] Chuck, how about you coming up and showing us. Give me
a drawing illustrating the Exterior Angle Theorem and tell us
what the theorem says. [The student steps to the overhead, draws
a triangle having an exterior angle illustrated and gives the
correct statement of the theorem.]

Okay, the exterior angle is greater than either of the remote interior angles. Thanks Chuck, you did a good job. All right, this theorem will be useful to use in proving the two new theorems for today.

The second thing we need to review is the ways we have had so far of proving triangles congruent. Either theorems or postulates. [Various students from around the room call out the different ways until all have been identified. The teacher writes them on the overhead as they are mentioned.]

The third thing that we need to review before proving today's theorems is indirect proof. To help us do this, we will prove the following indirectly. The teacher displays an overlay showing the following:



If $m\angle 1 = m\angle 2$, then $l_1 \parallel l_2$

Figure 10

Although we have not had this theorem yet, I'm using it as an example because it is quite easy to follow and it illustrates very well the use of indirect proof. [The teacher then spends a few minutes explaining how the theorem is proved using an indirect approach.]

Okay, now that we've spent some time reviewing these three topics, we're ready to prove our two theorems for today. Now the first and third things we reviewed, that is, the Exterior Angle Theorem and indirect proof play an important role in proving these theorems. [At this point the teacher launches into a statement of the two theorems and proceeds through their proofs.]

CLIP 8 RUNNING TIME: 3-1/2 MINUTES CLIP LOCATION: T1 607-637

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals, Outlining, and Giving Reasons

SUMMARY OF CLIP 8

In this clip, we see a male teacher with four years of experience instructing a low ability first-year algebra class of sophomores. The teacher's long range goal is to teach the students six techniques of factoring. His specific goal for this lesson is to explain how one factors the difference of two squares.

An attempt is being made at using three initiating activities. Early in the lesson the teacher states his long range goal--to teach the students factoring. A bit later he tells the class specifically what he hopes they will learn during the lesson, namely, how to factor the difference of two squares. The teacher also uses an outline of the major points to be covered during the class' study of the section on factoring. The teacher uses a third initiating activity when he provides the stueents with a reason for knowing how to factor.

QUESTIONS FOR DISCUSSION

1. What reason is given to the class for studying factoring? What is your reaction to the teacher's use of this reason with a class of this ability level?

2. Do you think that the teacher's statement of the goal for the day's lesson was clear? If not, tell how you would clarify it.

3. Do you feel that the teacher's decision to use an outline was a sound one? Support your answer.

TRANSCRIPT OF CLIP 8

T: The thing that we're going to start working on today, and we've
done a little bit of it already, is factoring. Now there will be 1
six different types of factoring that we're going to talk about.
We've already talked about one of them, and that is the common
term. [As the teacher mentions each type of factoring, he lists
them on the board as shown below: 2

1. Common term
2. Difference of two squares
3. Grouping
4. Perfect square trinomial
5. Trial and error (leading coefficient of 1)
6. Trial and error (leading coefficient not 1)]

Here is the type that we will discuss today--the difference of
two squares. The third type we talk about is grouping. [The 1
teacher then completes writing the list.] Okay, these are the
six different types, common term; we'll go over that a little
bit before we start today. The difference of two squares and
grouping. (I think it's appropriate here to mention that
grouping is used only when we have an expression to factor that
contains four or more terms.) "Perfect square trinomials" refers
to another special group of polynomials that we must learn to
factor, and then there are two types of trial and error
factoring techniques that we will learn. The first is when
the leading coefficient is one, and the other will give us a
technique for trial and error factoring when the leading coefficient is not one.

Now this topic of factoring, if you stay up to date and stay
with it will be real easy. We're going to be using factoring
for almost all of the remaining part of the year in the work 6
that we do related to solving equations, reducing fractions
along with other topics. If you can factor well, it's going
to make your work much easier. If you cannot, that is, if you

put off doing your homework and learning these various techniques, it's going to make your work much harder. So stay up to date on this stuff, and it will make your work much easier the rest of the year. The first type that we've had already is illustrated by this problem. [The teacher then begins to teach the new material on factoring.]

CLIP 9 RUNNING TIME: 10-3/4 MINUTES CLIP LOCATION: T2 10-164

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Giving Reasons

SUMMARY OF CLIP 9

This clip illustrates a male teacher with fifteen years of experience working with a class of below average freshmen in an introductory algebra class. The teacher's goals are, first, to show students how a knowledge of percentages can be important in earning a living, and, secondly, to develop some consumer awareness of advertising.

The initiating activity used in this lesson was an attempt on the part of the instructor to provide the students with some reasons for their studying percentages. Note that in this clip, the content of the initiating activity formed an important part of what the teacher wanted the students to learn.

QUESTIONS FOR DISCUSSION

1. What are the reasons that the teacher gives for studying percentages? Do you feel that these reasons were meaningful for the students? Explain your answer.

2. Do you think that the teacher's use of newspaper ads was a good one? How else might he have used such ads to initiate the study of percentage?

3. Although not many of the students in this class are shown, the audio portion of the clip reveals quite a lot of noise and talking. Do you feel that the instructor responded appropriately to this noise? How else might he have handled this problem? What would you do under similar circumstances?

4. How might one use such sale ads to augment the study of percentage? What other resources might one find in a newspaper that could be of value in studying mathematics? Be specific.

TRANSCRIPT OF CLIP 9

T: The month of January is a very appropriate time of the year to be studying percentages. This is because there are many sales this time of year which advertise certain percentage savings to customers on all sorts of items. You will notice on the front board that I have displayed a number of newspaper advertisements that inform the reader of savings ranging from 10% to as much as 50%. If we study percentages and know how to use them, we can many times save ourselves some money. All of us are working to get as much for our money as we can. So when we see ads claiming 6%, 10%, 20% or more discounts or sales, what does this mean to us? Is it really to our advantage to buy at this time of year rather than, for example, in the middle of the summer? 6

Well, let's take a look at this particular newspaper ad for a lady's coat. The ad says 20% to 50% off. Now ... [At this point, the teacher looks with the class at several of the news ads. He points out how the class might actually compute the amount of money they would save based upon the various prices listed in the ads. The teacher emphasizes again that a reason for studying percentages is so they (the students) as consumers will be able to compute for themselves when a "bargain" is, in fact, a good buy. He also emphasizes that in one of the ads which claim 20% to 50% off on some clothing items none of the specific sale items listed in the ad had been reduced 50%. Most were between 20% and 25%. Without a knowledge of percentages and how to compute them, the teacher mentions, it's fairly easy for the public to think it's getting larger savings than it actually is.] That's one of the reasons why you have to be able to understand this.

Now many of you are shortly going to be interested in finding jobs. Some of you already have jobs. Usually you work by the hour. But if you get a job as a salesman, say in a clothing store or a department store, often times your salary will be a certain percentage of what you sell. Your knowledge of percentage can be very helpful to you in figuring out what your salary will be. Say, for example, that your goal is to earn $10 a day. The question is, how much do you have to earn in order to make it. 6

Well, let's look at this chart. [The teacher directs the student's attention to a prepared chart at the front of the room.]

We will assume in this problem that your commission will be 7%. So if you sell enough things in one day, you will make your $10. Okay, here are the things that you sell in one day in the clothing store. Seven items. By the time you sell a dress for $20, a scarf, socks, shoes, handkerchiefs, a coat and a shirt, you find upon adding your sales that you have sold $145 worth of material. Now multiplying 145 by 7%, i.e., .07, you find that at the end of the day you have made $10.15. So you see that in order for you to earn $10 as a salesperson operating on a 7% commission, you would have to sell $145 worth of material in one day. [The teacher then goes through another itemized example of what a salesperson might make in a hypothetical situation.]

I hope these examples will give you some idea of how important percentages are in our daily lives. Further examples of percentages can be found on the sports page of a newspaper, in the batting averages of baseball players, shooting averages of basketball players, etc. [The teacher then asks for questions and receives comments from two students who have had recent experiences in saving money on the purchase of sale items.]

CLIP 10 RUNNING TIME: 23 MINUTES CLIP LOCATION: T2 166-427

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Using Historical Material

SUMMARY OF CLIP 10

In this clip, we see a female teacher with two years of teaching experience instructing a first-year algebra class of accelerated freshmen. There was no new material being taught in this class. The teacher's goal is to spend class time in reviewing how one manipulates expressions containing exponents.

The initiating activity that the teacher is attempting is to make use of historical material.

QUESTIONS FOR DISCUSSION

1. Did the students seem interested in the teacher's initiating activity? Use incidents in the tape to back up your answer.

2. Was the initiating activity too long? If so, make suggestions for shortening it.

3. What was your reaction to the teacher's use of slides in her presentation?

4. In what classes and with what topics might this initiating activity be appropriately used?

5. In watching the clip, you probably noticed that there was a large amount of student participation. To what do you attribute this participation?

6. Are there any particular age groups or ability levels for which this initiating activity is especially appropriate?

7. While there was a lot of student participation, much of it was done by four or five students in the class. How might the teacher have gotten more students involved in the discussion?

8. Would you recommend the inclusion of the reference to Stanley Kowalski and his exponential notation in this initiating activity? What are some possible pros and cons related to its inclusion?

TRANSCRIPT OF CLIP 10

T: What's the news across the nation? It's called exponential notation. "Mathatory" powers you're going to see. Ladies and "gents," Math-In looks at the news. Math-In presents news of the past. We take you back to the 1500's where we'll talk about the latest rage across the international scene. Here are some of the places Math-In will take you. [At this point the teacher begins playing music associated with France, Italy and Switzerland. As the music plays, she shows and narrates slides which she had taken the previous summer in each of the countries.] Yes, Math-In takes you to France, to Italy and to Switzerland where one of the great topics of the fifteenth and sixteenth century was happening. Mathematicians from all of these countries were trying to decide how they were going to represent what we know now as exponential notation. Let's see what some of these mathematicians came up with.

T: You know in the past you've worked with exponents, for example, x^3 and y^4. We'd like to talk today about what mathematicians did in trying to come up with our present-day notation. After all, someone had to invent the notation we use. As you heard earlier, European mathematicians were busy in the fifteen and sixteen hundreds developing symbolism to represent numbers raised to powers. So let's now take a look at a few of these developments to see who finally came up with what we use today. I thought you might appreciate seeing scenes from the countries where some of these mathematicians worked. I happened to be in each this past summer. So today's topic will be exponential notation and a look at its development. We're going to check on some mathematicians who lived in France, Italy, Switzerland and even Poland.

The first one I'd like to talk about today is a man named Buteo. He lived around 1559 and that's when these results were published. [Here the teacher displays an overlay with the following symbols on it:]

$7\rho \qquad 7\lozenge \qquad 7$⬚

All right 7ρ was meant to stand for 7x. Okay, the diamond shape was used to stand for $7x^2$ and this cube, what do you think it stands for?

S: The third power.

T: Seven-x-cubed. So that was Buteo's idea for representing numbers in exponential notation.

S: What did he use for x^4?

T: I don't know what he used for x^4. You might want to do some research on that. Do you want to take down his name? Another Italian by the name of Bombelli published his mathematics in 1572. However, he had done his work 20 years earlier. Here is an equation he worked with.

[The teacher displays an overlay with $4.p.R.q.\lfloor 24.m.2\overset{\downarrow}{\breve{0}},\rfloor$ Equale à $\overset{\downarrow}{\breve{2}}$. on it.]

Since Bombelli was an Italian, there is an Italian work in this expression. I wonder if there are any Italians in here that could help us translate this? Do you have any ideas what all this notation might stand for? [Pause] Does anybody have any ideas at all?

S: The one word might stand for equals.

T: Okay, good, any other ideas. We have a p., R., q. and m. along with some other symbols.

S: The capital l and the backward l may stand for parentheses.

T: Okay, parentheses, very good. Anything else I could put down?

S: The little ones written above the lines may be exponents.

[This sort of discussion continues for several minutes with the teacher and students trying to translate the expression. After a while, the teacher interprets the remaining symbols and writes the expression $4 + \sqrt{24 - 20x} = 2x$ on the overlay. She then reviews the expression pointing out what each symbol means.]

S: Can we do another one?

T: Sure. Let's stick with Bombelli for a while and see if you can tell me what these three notations might mean. [The teacher puts on an overlay with the following symbols:

$$\overset{\underset{\smile}{1}}{2},\quad \overset{\underset{\smile}{2}}{2},\quad \overset{\underset{\smile}{3}}{2},\quad \overset{\underset{\smile}{1}}{1},\quad \overset{\underset{\smile}{2}}{1},\quad \overset{\underset{\smile}{3}}{1}$$

As she asks what each one means, various students respond spontaneously and with little difficulty.] You people are getting pretty good at this. Let's try working backwards now. That is, let's start with present-day notation and see if you can write it as Bombelli would have. For instance, how would Bombelli have written x^2?

S: As 1 with a two in a little half-circle.

T: Tell me how he would have written y^2.

S: It would be the same.

S: Yes, it would be the same.

T: You think it would be the same huh? Remember that Bombelli just wrote the coefficient and then the exponent in a little half-circle. Do you see any problem here?

S: Yes

T: What if you wanted to do a problem like $x^2 + y^2$? How would Bombelli have handled this? [Various students suggest some ideas for symbolism. The teacher then tells the students that Bombelli didn't develop a symbolism for such problems.] That's why we don't use Bombelli's notation today. He didn't develop a notation for handling such expressions. His symbolism was very limited.

Another Italian, Pietro Cataldi, who lived in the 1600's came up with this notation. The teacher displays another overlay with $\cancel{0}$, $\cancel{2}$, $\cancel{3}$ and $\cancel{4}$ written on it. In this notation, four with a line through it means x^4. [Pause] What do you suppose three with a line through it means?

S: x to the third.

S: And 2 with a line through it means x squared.

T: Right. What do you suppose the zero with a line through it means? It's not the null set.

S: Probably x to the zero power.

T: Yes, I think you're right. How would he have written x to the first power?

S: One.

T: One?

S: x

T: You mean a variable or a 1 with a line through it?

S: One with a line through it.

S: It doesn't make any difference.

T: I think it would be a one with a line through it. Do you see any limitations with this kind of notation?

S: Yes. You still have the same problem as before.

T: All right. Now we'll go to Switzerland and a fellow by the name of Jobst Bürgi. We're still in the 1600's now, in fact 1619. This was his notation. He used Roman numerals like in the following: [The teacher displays another overlay with the following written on it:]

$$\overset{\text{vi}}{8} + \overset{\text{v}}{12} - \overset{\text{iv}}{9} + \overset{\text{iii}}{10}$$

So how would we translate this expression?

S: Eight to the 6th plus twelve to the 5th minus nine to the 4th plus ten to the 3rd.

T: That's close, but I think Mr. Bürgi wanted to use some variables also.

S: Oh, I see. 8x to the 6th, 12x to the 5th, 9x to the 4th and 10x to the 3rd.

T: All right, as with Bombelli and Cataldi, Bürgi just stated the coefficient with its exponent with the understanding that the variable would be written. Finally we come to the famous French philosopher and mathematician who is credited with the exponential notation that we are used to today.

S: Descartes!

T: Yes, that's right, René Descartes in 1637. Here is his notation. For 7x to the first, he wrote 7x, etc. He also come up with the important idea of simply changing the variables so that the difficulty we encountered earlier with the other notations we looked at was no longer a problem. So believe it or not, the exponential notation you've been working with for the last several weeks is a result of the efforts of René Descartes who developed it in 1637 and that other mathematicians had worked on in the 1400's and 1500's.

So now that you can have some appreciation for the work that mathematicians have done on exponential notation, we move into a review of some of the rules dealing with exponential notation. I thought that this would be a good idea because this material will be on your semester exam coming up in about two weeks. [At this point the teacher spends the rest of the period leading a review of the laws dealing with the manipulation of exponents.]

CLIP 11   RUNNING TIME: 11-3/4 MINUTES   CLIP LOCATION: T2 427-540

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Reviewing Subordinate Information and
Presenting a Problematical Situation

SUMMARY OF CLIP 11

This clip shows a male teacher with six years of experience teaching a geometry class of accelerated sophomores. Although the students have learned the definition of similar triangles, they have not yet learned of any ways of proving triangles are similar (i.e., by AAA, SAS, SSS or AA). The teacher has several goals for the lesson. He first hopes to firm-up in the student's mind what similar triangles are and how one recognizes them. He also sees this lesson as laying the groundwork for a statement and eventual proof of the AAA theorem for proving triangles similar. He also sees as one of his goals to present the students with a practical application of the use of similar triangles.

The teacher is attempting to use two initiating activities in this clip. The first is clear from the initial utterances of the instructor.

He spends some class time in reviewing the definition of similar triangles and, more specifically, what it means for corresponding sides of similar triangles to be proportional. The second initiating activity is that of presenting the students with a problematical situation, namely, the apprentice-surveyor problem. After presenting the problem and allowing the students time to work on it, the teacher discusses its solution with the students. After this, the teacher discusses the AAA similarity theorem with the class and instructs them to outline its proof for homework. This discussion of the AAA theorem is not shown on the clip.

QUESTIONS FOR DISCUSSION

1. Do you believe that the goal of the lesson was clear to the students? With this ability level, is it important to state the lesson's goals, or will the students just naturally pick it up?
2. Would reversing the order of the initiating activities have improved the presentation? Give reasons to support your answer.
3. Suppose you were asked to teach this class. How would you modify this teacher's use of initiating activities?

TRANSCRIPT OF CLIP 11

T: Okay, we've talked about the definition of similar triangles. Can anyone give me the definition or tell me something that is true of similar triangles? The main thing was what? 5

S: The shapes of the similar triangles are the same.

T: Okay, the shape is the same, and what is it about the sides of the triangle?

S: The sides are all proportional.

T: Right. How do we write that mathematically? [At this point, the teacher has drawn the following figures on the board:]

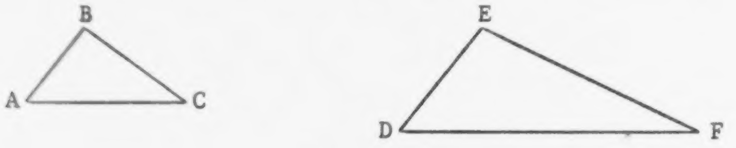


Figure 11

S: D over F?

T: Well, here, like side AB in triangle ABC ____.

S: is proportional to DB.

T: Right. So the ratio AB over DE would have to equal the ratio of BC to EF. And finally we have the last ratio AC over DF. Okay, that's what it means when we say that the sides are all proportional--the ratio between the corresponding sides is the same for all three sides of the triangles. [The teacher writes AB/DE = BC/EF = AC/DF on the board.] Also the corresponding angles will be equal. All right, so at this point everyone should definitely know what we mean by the term similar triangles.

Now what we've been working on with the parallel proportion theorem is a way which will enable us to prove some theorems telling us how we can prove triangles similar. I think at this point, we almost have it with the corollary 158. [The teacher places the diagram on the board.]

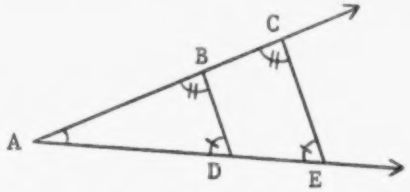


Figure 12

Remember this? If segment BD is parallel to $\overline{EC}$, then we can show that the ratio of AB to AC will be the same as what?

S: AD to AE.

T: That's right. We talked about that yesterday; we said that we don't quite have similar triangles yet because we don't know if the third sides are proportional. We should, however, be able to get the third sides proportional. It really shouldn't be too hard. Now if we can get these third sides proportional, then we can see a connection here between the angles of the triangles. If the two triangles ABD and ACE are similar, then their corresponding angles will be congruent. Why are angles D and E and angles B and C congruent?

S: They are corresponding angles of parallel lines.

T: Okay, so we ought to be able to get some theorems out of this corollary for similar triangles. If you think about it, similarity deals with shape, right. The shape of figures. What determines the shape of triangles?

S: The angles.

T: Take a quadrilateral for example. If you have two quadrilaterals, is it their angles that will determine whether they're similar? [Pause] What if we have two quadrilaterals that have the same angles. [The teacher draws a rectangle and a square on the board.]

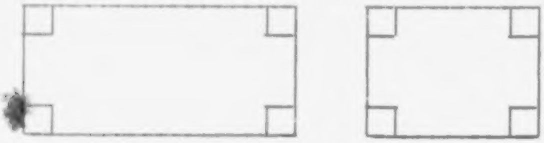


Figure 13

S: No

T: No. Just because the angles of two quadrilaterals are equal doesn't necessarily mean that they are similar. You can see this clearly if you consider the square and the rectangle here on the board. Their angles are congruent, but the figures are not similar. Well, what about triangles. Would you be able to have similar triangles if the angles are congruent?

S: Yes

T: I think you can see that especially by examining the figure accompanying the corollary we were discussing earlier.

7 Well, I have a problem for you today which has something to do with what we've been talking about. It's the old apprentice-surveyor problem. Maybe you've heard of this one before. We have a man here who is a surveying student. [The teacher draws the diagram shown below on the board.]

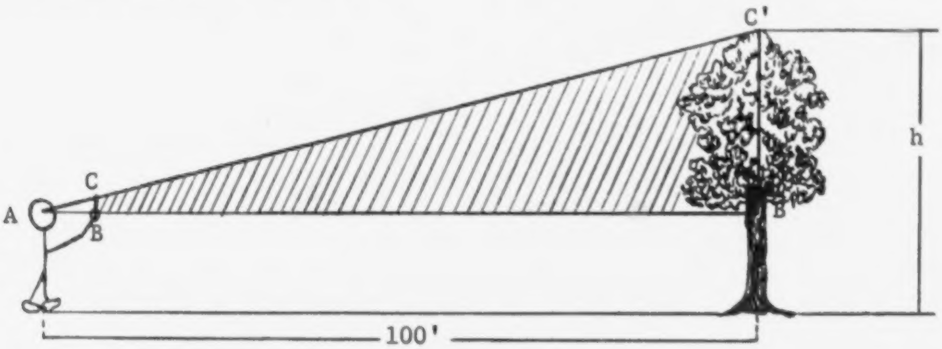


Figure 14

Part of the requirements for a course he is taking is to go out and perform a rudimentary surveying problem with a minimum of equipment. Now, his specific problem is to determine the height of a big tree with no sort of sophisticated equipment. As a matter of fact, all he has is a six inch ruler and a piece of string. All right, so here is what he does. See if you can figure out why his procedure works. Hopefully you will be able to see what this has to do with similar figures. He walks up to the tree and he notes a spot on it that is roughly the height of his eyes above the ground, say five feet. Then he paces off 40 paces from the base of the tree. Now when you're a surveyor, you make a pace exactly two-and-one-half feet, so he moves a distance of 100 feet from the tree. So he stands 100 feet from the tree. Now remember that he has a six-inch ruler along with a piece of string which he ties to one end of the ruler. Now he holds the ruler in front of him in such a way that the ruler blocks out the top part of the tree from the five foot mark on up. He then stretches the string from the ruler to his eye. Determining the length of string from his eye to the ruler, he is able to compute the height of the tree by using the simple formula $h = (100\ .\ 6)/AB + 5$ where AB is the length of the string from his eye to the ruler. So, looking at this formula closely, we find that this surveying student is able to determine the height of the tree by taking just one, simple measurement of the length of the string from his eye to the ruler. For example, if the length of AB is 12 inches, how high will the tree be?

S: Fifty-five feet.

T: Okay, 55 feet, and that happens to be right. Remarkable! So there you have it, the old surveyor's apprentice problem. How did he come up with that formula? Can any of you see how? What does this have to do with similar triangles? Well, I have the problem reproduced on a sheet of paper here. I'll pass these out and let you work on this a while. Maybe you can figure out why this formula works. Also there are a couple of other relevant questions on the sheet. [At this point, the instructor distributes the ditto sheets and allows the students about ten minutes to work on the problem either in small groups or individually. After allowing time for individual study, the teacher works through the problem at the board with the assumption that $\Delta ABC \sim \Delta AB'C'$.]

CLIP 12   RUNNING TIME: 11-1/2 MINUTES   CLIP LOCATION: T2 542-640

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Using Historical Material and Presenting a Problematical Situation

SUMMARY OF CLIP 12

In this clip, we see a male teacher with 12 years of teaching experience teaching a geometry class of average ability sophomores. The teacher's goal is to get the students to sense a need for Euclid's parallel postulate (i.e., Playfair's axion) in their development of geometry.

He tries to accomplish his goal by posing a problematical situation, namely, of asking the class to prove that the summit angles of a Sacherri quadrilateral are equal. Once the class has accomplished this, he then asks them to show that the summit angles (i.e., angles A and D, see Figure 15) are both right angles. Another initiating activity being used in this clip is that of historical material. In this case, however, the historical and problematical initiating activities are inseparable. [The teacher begins the class by passing out a little sheet with the following problem on it:

Given: $\overline{AB} = \overline{DC}$
$\overline{AB} \perp \overline{BC}$
$\overline{DC} \perp \overline{BC}$

Prove: $\angle A \cong \angle D$

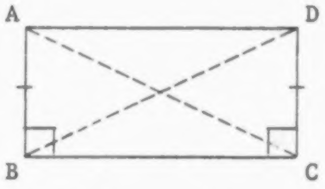


Figure 15

QUESTIONS FOR DISCUSSION

1. How would you rate the appropriateness of this initiating activity for the ability level of the students shown in this clip? Why do you feel as you do?
2. In a later interview, the teacher indicated that he thought that he was successful in getting the students to sense a need for some sort of postulate concerning parallel lines in order to be able to prove that the summit angles have a measure of 90. Judging from the clip, would you agree or disagree with the teacher? Explain your answer.
3. The Parallel Postulate is, of course, a topic that every high school geometry teacher teaches. How would you initiate its study? Be specific.

4. Do you feel that the teacher's presentation was well organized. Give evidence from the video-tape to corroborate your position.

TRANSCRIPT OF CLIP 12

[The teacher begins the class with a problematical situation by passing out a ditto sheet containing the following problem:]

Given: $\overline{AB} = \overline{DC}$ Prove: $m \angle a = m \angle D$
$\overline{AB} \perp \overline{BC}$
$\overline{DC} \perp \overline{BC}$

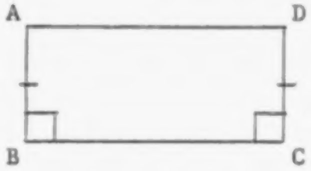


Figure 16

T: The hint I'll give you to try to establish that angle A and angle D are congruent is to draw the auxillary line segments AC and BD. [The teacher then allows the class five or ten minutes to work individually on the solution.]

4,7

Okay, let's take a look at how you might go about proving this. [During the next several minutes of class time, the students and teacher jointly arrive at a method for establishing that the measure of angle A equals to the measure of angle D. The teacher then introduces another problem.] Now that we have established that the measures of angle A and angle D are equal, let me ask you another question. What is the measure of these angles?

S: Ninety.

T: Okay, why?

S: I don't know.

T: But why? You must have some reasons for saying ninety. [Pause] Does anybody else have any other ideas? Do you agree with Mike on the ninety? Do you disagree? How many of you agree that it is ninety? All of you agree that the measures of both angle A and angle D are ninety? Why? [Pause] Segment AB is congruent to segment DC. Is that all I know?

S: You've got to be able to prove that segment AD is congruent to segment BC.

T: Okay, well, how am I going to prove that? [Pause]

S: Couldn't you do it just by saying that segment AB and segment DC are parallel?

T: Ah hah!

S: Because they are both perpendicular to segment BC. Then AD would equal BC because two parallel lines are everywhere equidistant, and we would show that triangle ABC is congruent to triangle CDA; so angle D would be a right angle.

T: You have wrapped up the whole thing right there. What is the concept that we need in order to prove that angle A and angle D are right angles?

S: Parallel lines.

T: Right. We need that concept. Then we would be able to get AD equal to BC (see Figure 16). Once we had these segments equal, what could we show about the angles A and D?

S: They would be right angles.

T: Right, then they would have measures of 90. This particular quadrilateral that we have been working with has a special name. Remember that we have seen in this quadrilateral (see Figure 16) that while we can prove angle A equal to angle D, we cannot show that the angles are right angles unless we assume Mike did earlier that the distance between two parallel lines is constant. The special name given to this kind of quadrilateral is a Saccheri quadrilateral. What Saccheri tried to do was to show, using the method of proof I showed you earlier, namely, an indirect proof, that both of the angles A and D could not be obtuse and both could not be acute. So what would they both have to be?

S: Right angles.

T: Now Saccheri was successful in showing that angle A and angle D could not be obtuse. He was not successful in showing that the angles could not be acute. Now all of this work that we have been discussing today has a very long history. It all goes back to something that Euclid said. In his fifth postulate, he said that suppose you have two lines (l_1 and l_2 in Figure 17) that are cut by a third line t. Also, suppose that the interior angles on the same side of t, let's call them 1 and 2, have measures whose sum is less than 180. Then what do you suppose will be true?

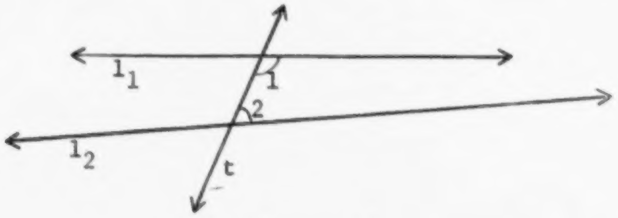


Figure 17

S: The lines will intersect.

T: Where will they intersect, on the same side as the interior angles or on the opposite side?

S: On the same side.

[The class continues discussing Euclid's fifth postulate.]

CLIP 13 RUNNING TIME: 13 MINUTES CLIP LOCATION: T3 12-206

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Outlining and Reviewing Subordinate Information

SUMMARY OF CLIP 13

This clip shows a male teacher with three years of teaching experience teaching an advanced algebra class (second year algebra) composed of students of above average ability. The class is shown beginning the study of a new chapter. The teacher's goal is to teach the students how to manipulate zero and negative exponents.

The teacher uses the first ten minutes of the class period to preview the topics that will be covered in studying the chapter. While technically not an initiating activity, this portion of the class period is included because it does illustrate one way of introducing a chapter.

The main initiating activity the teacher uses is a review of subordinate information. This occurs in the dialogue right before he introduces the definitions of what numbers raised to zero and negative powers mean. The instructor spends time reviewing the laws for positive integral exponents. He is especially interested in the law, $a^m/a^n = a^{m-n}$, and how its application when $m = n$ and $m < n$ make the definition of $a^0 = 1$ and $a^{-x} = 1/a^x$ where $x > 0$ seem reasonable.

QUESTIONS FOR DISCUSSION

1. Do you think that the teacher's effort to preview the chapter is valuable from the student's viewpoint? Why or why not?
2. How might the teacher have improved his preview activity?
3. This class was an early-bird class. That is, it met at 7:30 a.m. Should such a time factor enter into a teacher's planning? Tell how. Do you think that the teacher shown in this clip considered meeting time in making his plans? Tell why or why not.

TRANSCRIPT OF CLIP 13

T: What we're going to do today is we're going to start Chapter 5. I've given you the list of objectives for this chapter. Also, I've given you the list of assignments. When we get to a particular section, I may find it necessary to insert extra material for you to do. On the other hand, I may find it necessary to delete certain material in the assignment sheet because you don't need all of the work that is indicated there. I will do this depending on how I think things are going. We'll spend approximately three weeks on this chapter. The chapter basically deals with fractions. Now the fractions in this chapter are going to be a little different than the type of fractions that we dealt with in the past. What I thought I would do first today is to go through the chapter with you and discuss some of the things that we will be discussing in days to come.

2 The very first section on about page 157 deals with zero and negative exponents. What we're going to do in this section, which we will be discussing later today, is to talk about the laws that we had for positive exponents in the last chapter. We're going to add two new definitions of what we will mean for a number to be raised to the zero power and what we mean for a number to be raised to a negative power.

The second section, 5.2, talks about rational expressions and here we're going to talk about fractions--fractions that have polynomials for the numerators and denominators. Things that look like $x^2 + tx + 3$ divided by $x^2 + 6x + 9$. We will examine the restrictions on such fractions, that is, the value(s) of the variable that will make the denominator zero.

In the third section, we will talk about simplifying these rational expressions. You already know that a fraction such as 4/6 is not in simplest form. So you reduce it. We're going to do the same type of thing with rational expressions. This is one reason why it was necessary for us to study the factoring of polynomials in the last chapter, that is, so that we would be in a position to simplify rational expressions.

Section 5.4 talks about the multiplication and division of rational algebraic expressions, while section 5.5 deals with the addition and subtraction of such expressions. In this section, we'll find that in order to add or subtract these fractions, it will be necessary to find common denominators just as it was in adding or subtracting numerical fractions.

The sixth section will discuss something that will be new to most of you, namely, complex fractions. A complex fraction is going to be a fraction that contains fractions; we're going to learn how to simplify such fractions. I think that most of you will find this to be an interesting topic.

Section 5.7 will not be anything that is very new to us. You already know how to solve quadratic equations. We will solve quadratic equations in this section also; the only difference being that the quadratics in this section will have fractional coefficients.

Section 5.8 contains more word problems. These word problems, however, unlike any we have studied so far, will involve equations having fractional coefficients.

In section 5.9, we will learn about extraneous roots. That is, roots which arise in the solution of fractional equations, but which upon checking turn out not to satisfy the equation.

Sections 5.10 and 5.11 will be deleted. I figure that you already know enough about these to warrant our skipping them. Basically that's what we'll be covering in here over approximately the next three week period.

All right, the first thing I want to talk about today is section 5.1, so if you'll open up your books to p. 159, we'll proceed. If you'll remember, back on p. 123, we talked about some basic laws concerning exponents. When you dealt with $a^m \times a^n$, what did you get? Ron? 5

S: a^{m+n}

T: a^{m+n}. If you talked about $(a^m)^n$, you wound up getting what?

S: a to the mn power.

T: a to the m times n power. If you had the product of ab, and you raised that to the m power, then that would give you what? Mary?

S: a to the mth power times b to the mth power.

T: If you had a divided by b all raised to the m power, then that would give you what? Jerry?

S: a to the mth divided by b to the mth.

T: Okay. Now of particular interest to us today is the expression of a^m/a^n. What does that turn out to be?

S: a^{m-n}

T: Okay, a to the m-n power, and that turns out to be a positive exponent if $m > n$, right? So we get a positive exponent if m is bigger than n. What do we get if $n > m$? [The instructor then goes through some examples to make reasonable the definition of a^0 and a^{-n}.]

CLIP 14   RUNNING TIME: 5 MINUTES   CLIP LOCATION: T3 208-270

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals, Reviewing Subordinate Information, and
Presenting a Problematical Situation

SUMMARY OF CLIP 14

In this clip, a male teacher of 14 years experience is instructing a pre-algebra class of below average ability. The concept being taught is that of least common multiple. Specifically, the teacher hopes that students will acquire skill in using the prime factorization technique to find the least common multiple of two or more numbers.

Several initiating activities are being attempted in this clip. At the beginning of the lesson, we see the teacher stating the goal by telling the students that "Today we're going to talk about least common multiples."

The teacher makes the goal clearer in his next few remarks by telling in more detail what he means by the least common multiple of two numbers (10 and 18 in his example). Also integrated into his opening remarks is a problematical situation. He does this by writing the numbers 10 and 18 and 3, 30 and 45 on the board, and then by asking the class how they could find the smallest number that is divisible by, for example, 10 and 18. This problem serves as a theme through much of the class, and is not fully resolved until later in the period. The third initiating activity illustrated in this clip consists of a review of subordinate information. Before showing the students the procedure for determining how to find the l.c.m. of two or more numbers, the teacher spends time in reviewing two methods for prime-factoring a number. He also reviews some of the tests for divisibility that the class has studied.

QUESTIONS FOR DISCUSSION

1. What was the goal of this lesson? Did the teacher state this goal clearly? Support your answer by specific references to the videotape. If your answer to this question is no, give some specific suggestions as to how the instructor might have clarified his goals.

2. Did you feel that the class was as lively as it might have been? How might the instructor have changed his use of the initiating activity, Reviewing Subordinate Information, in an effort to spark the class? What other suggestions can you make for livening up the class?

3. If you were teaching this same topic to this class, how would you modify the initiating activities?

4. Do you feel that Reviewing Subordinate Information was a wise initiating activity to use with this class? Explain.

TRANSCRIPT OF CLIP 14

T: Today we're going to talk about least common multiples. For 1
example, suppose we have two numbers like 10 and 18 or three

numbers like 8, 30 and 45. [The teacher writes these numbers on the board.]

Let's first consider 10 and 18. What we're going to do today is
to learn a procedure for determining the smallest number into which 1
both 10 and 18 will be divisible. This number will be called the
least common multiple of 10 and 18. So the problem we have before 7
us is this: Given two numbers (or three, or four or however many
you wish), how can we find, without using trial and error tech-
niques, the smallest number that has our given two, three or what-
ever numbers as factors?

All right, now in order to answer this question, we must know something about prime numbers and how to express a number as a product of primes. Remember that we learned earlier that a prime number is a number whose only factors are itself and one. We also learned that it was possible to express every number as a product of prime factors in a unique way. One way of doing this is to use a method known to some of you as the branching method. So for 10, the prime factorization by the branching method would be 2 x 5. [The teacher uses the diagrams below which he places on the board.] 5

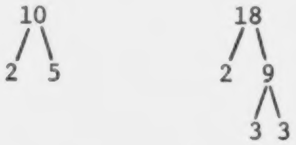


Figure 18

Doing the same thing for 18, we see that its prime factorization is 2 x 3 x 3 or in exponential form 2 x 3^2.

Here is another way of finding the prime factorization of a number. Take, for example, 8. Gind the smallest prime number that will divide 8. It's 2. [As the teacher explains this method, he writes what appears below on the board.]

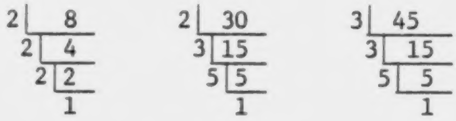


Figure 19

We get a quotient of 4 which again has the smallest prime factor of 2. The quotient now is 2 which is again divisible by 2, giving us a quotient of 1. Hence our prime factorization of 8 is 2 x 2 x 2 x 1 or 2^3.

> Illustrating this procedure again, consider another number we had earlier--30. It's smallest prime factor is 2. Three is the smallest prime factor of the quotient, 15, and 5 is the smallest prime factor of the quotient, 5. So our prime factorization of 30 is 2 x 3 x 5 x 1 or just 2 x 3 x 5.
>
> Okay, so now let's try 45. Going through our successive divisions, we find the prime factorization of 45 to be 3 x 3 x 5 or 3^2 x 5. [At this point in the presentation, the teacher proceeds to explain how to find the least common multiple of 10 and 18.]

CLIP 15 RUNNING TIME: 3-1/2 MINUTES CLIP LOCATION: T3 272-312

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals and Presenting a Problematical Situation

SUMMARY OF CLIP 15

In this clip, we see a male teacher with 10 years of experience teaching an advanced mathematics class (analytic geometry and trigonometry) of average ability. The teacher's purpose in this lesson is to teach the students the law of sines and how it is applied in solving oblique triangles.

The teacher is attempting to use two initiating activities. The first is to state the goal of the lesson. He actually does this twice. Right at the beginning of the class, he informs the students that they will be considering ways of solving triangles that are not right triangles. This is, in addition to being an immediate goal of the lesson, a long term goal of the next several days' work. The class had just completed a study of how to solve right triangles; this was their first lesson on how to solve triangles that do not contain right angles (i.e., oblique triangles). A more specific statement of the goal occurs later in the clip when the instructor spends some time explaining how the oblique triangle

ABC (see Figure 20) could be solved by forming two right triangles and then solving each of these. After suggesting this method of solution, the teacher tells the students that what he would like to do is to develop the law of sines which he implies will facilitate the solution of oblique triangles.

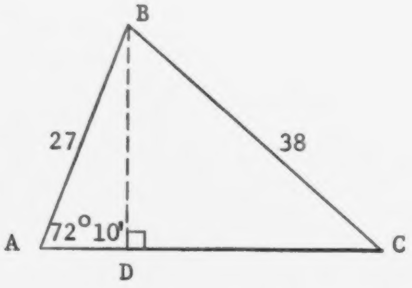


Figure 20

The other activity being attempted in this clip is the presentation of a problematical situation. The teacher does this early in the lesson by drawing an oblique triangle on the board and asking the class "How do you think we could approach such a problem (i.e., solve such a trinagle)?"

QUESTIONS FOR DISCUSSION

1. What initiating activity might have been particularly appropriate before beginning the study of how to solve oblique triangles?

2. Although the teacher shown was not consciously attempting to use a third initiating activity, some observers might be inclined to say that he made use of a review of subordinate information. Describe where. Would you have used a review if you had been in this teacher's position? Tell why or why not.

3. Do you feel that the teacher's statement of the goal of the day's lesson was clear enough so that the class knew what they were expected to learn? If so, tell why; if not, suggest ways of clarifying the goal.

4. When interviewed later, the instructor commented that he felt that his presentation was received well by the class, but he felt that he had done a poor job in initiating the lesson. How would you rate the overall quality of the initiating activities used in this clip?

TRANSCRIPT OF CLIP 15

T: Today we want to consider triangles that are not right triangles 1
and how we can go about solving such triangles. Thus far we've
considered only solutions of right triangles. For example, if
you're given a problem in which you were given two sides, one 27
let's say, and the other 38 and an angle of 72° 10', how do you 7
think we could approach such a problem? Ron?

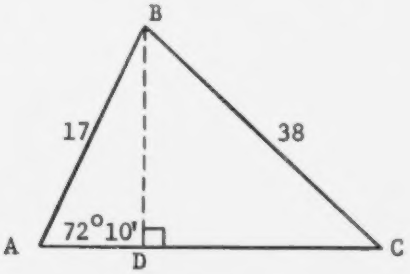


Figure 21

S: You could draw a line perpendicular to one of the lines.

T: Okay. Ron is recommending here that we construct an altitude so that we would be dealing with a right triangle situation. That's what we already know about. Okay, and so consequently when I draw this particular altitude, let's call the point here D, I would find out what side BD is; I could find out what side AB is by looking at this little triangle ABD. Correct? For example, how would I find side BD? Ruth?

S: Find the sine.

T: Okay, find the sine. The sine 72° 10' equals BD divided by 27. What about side AD? How would you find its length?

S: Use the tangent function.

T: All right, what would be your ratio? AB to what?

S: Oh! No, it would be the cosine function.

T: Okay, that sounds a little more logical. AD over 27 and we would
be able to find out what AD is, correct. Now look at what we've
got then. We would know BD, we would know AD and we would have
the whole triangle ABD solved. Then we could next go over and
work in ΔBDC couldn't we, that is, we could find DC and $\angle C$ and
eventually solve the whole triangle ABC. Now what I would like 1
to develop today is what is called the Law of Sines; we will find
that segment BD plays a central role in this development. To

see this, notice that segment BD is in both ΔADB and ΔBDC. Now remember that what we want to do is to solve the ΔABC. That is, we want to find the length of segment AC and the measures of ∠ ABC and ∠ C. The sine law, once we have derived it, will be very useful in helping us to do this without first solving the right triangles ABD and BDC. The sine law will enable us to solve ΔABC directly. [At this point, the teacher launches into a derivation of the Law of Sines.]

CLIP 16 RUNNING TIME: 5 MINUTES CLIP LOCATION: T3 314-369

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals, Reviewing Subordinate Information, and
Presenting a Problematical Situation

SUMMARY OF CLIP 16

In this clip, we see a male teacher with 10 years of experience teaching advanced mathematics (analytic geometry and trigonometry) to an average class. The teacher's goal is to derive the Law of Sines, and to show its application in the solution of oblique triangles.

The teacher is attempting to use two initiating activities. The first is illustrated at the beginning of the lesson. We see the teacher reviewing for the students the various sets of conditions under which the solution of right triangles is possible. He then illustrates by a numerical example how to solve a right triangle. The second initiating activity follows immediately after the numerical example. The teacher presents a problematical situation by drawing an oblique triangle on the board having two angles and the included side given (see Figure 22). He then states that the remaining angle is easy to find, but that finding the remaining two sides presents some difficulty.

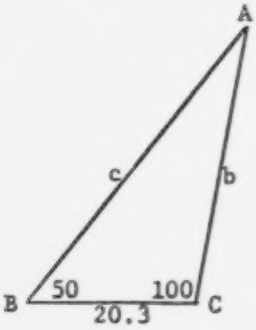


Figure 22

QUESTIONS FOR DISCUSSION

1. In this clip, you notice that the review of subordinate information is conducted in a very teacher-centered manner, i.e., there is almost no oral participation by the students. How might the teacher have changed his review so as to involve the class more?

2. Although the teacher was not aware of it, where else did he use an initiating activity?

3. Compare and contrast this clip with Clip 15 where the same subject matter is being taught. Which instructor do you feel has the more effective initiating activity relative to the purposes served by initiating activities as stated in the definition of initiating activities given earlier? Give your reasons for believing as you do.

TRANSCRIPT OF CLIP 16

T: One of the things that we did earlier was to look into this idea of solving triangles. In fact, that's what the last couple of assignments have involved--the solving of triangles under certain conditions. The only thing is that in all of the examples we 5 have had so far, that is, the triangles we have solved, have always been right triangles, and we found out that you have to have the right combinations of conditions in order to be able to solve the right triangles at all. The combinations of conditions needed to solve triangles are the same as for congruent triangles. So, for example, if they are right triangles, we have such things as hypotenuse-leg, hypotenuse-acute angle, leg-leg, these types of things. As a quick review of some of these things, suppose, for instance, you have a right triangle with one angle 23° and a hypotenuse of 10; we should then be able to go ahead and find out all of the other parts of the triangle. Since we already have three parts, it's not too difficult to find the other three. For example, the other acute angle will be the complement of 23°, that is 67°. A little more difficult problem is to find the other two sides, say we call them y and x.

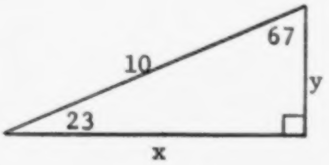


Figure 23

But even this isn't too difficult. For, from what we have worked on before, we know $y/10 = \sin 23^{\circ}$. So $y = 10 \sin 23^{\circ}$. All that remains then is to look up the sine of 23° and multiply it by 10, and you have the answer. Now you can also find x without too much trouble because you know that $x/10 = \cos 23^{\circ}$. Okay, and from here we can determine the value of x.

A more difficult problem arises when we consider the solution of 7
triangles other than right triangles. For example, let's consider one such triangle. [The teacher draws the triangle shown in Figure 22 on the board.]

For example, let's call this angle 50°, this one 100° and let the included side have a length of 20.3. Now the problem here is the same as before; solve the triangle, that is, find the other three parts. Okay, well the third angle is clearly 30°. But where we run into some problems is in finding the lengths of the remaining two sides. To see how we can do this, let's generalize our situation somewhat. Consider the triangle ABC with sides a, b and c opposite the correspondingly lettered vertices.

Now what we want to to today is to see if we can come up with
some sort of rule or formula that will allow us to plug in our 1
known data and obtain our missing information. In other words, we will derive a formula that will be of much assistance in solving certain types of oblique triangles. [The teacher then begins the derivation of the sine law through the use of coordinates.]

CLIP 17 RUNNING TIME: 15 MINUTES CLIP LOCATION: T3 316-517

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Using an Analogue

SUMMARY OF CLIP 17

In this clip, we see a male teacher with 13 years of teaching experience teaching an algebra I class of freshmen with somewhat below average ability. The teacher's goal is to teach the distributive property of multiplication over addition.

The only initiating activity being attempted in this clip is the use of an analogue. The analogue selected from the experiential field of the pupils is a fence. While a fence has many attributes--weight, texture, type of material used in the fence, density, etc.--we see the teacher emphasizing only those aspects of the fence, namely, height, width and area, that are relevant for development of the distributive law. Toward the end of the clip, we see the teacher going through several numerical illustrations of the distributive law leading us to the general formulation of it.

QUESTIONS FOR DISCUSSION

1. Was the initiating activity used in this clip appropriate for the ability level of the class? Would such an activity be appropriate for higher ability levels? Explain.
2. Do you think that the transition from the fence analogue to the statement of the distributive law could have been improved? If so, tell how; if not, explain.
3. How did the students respond to the teacher's use of the fence analogue?
4. Was the teacher's personality a significant factor in the implementation of this initiating activity? Explain why or why not.

TRANSCRIPT OF CLIP 17

T: Let's suppose that we have a fence that we want to paint. Let's say the new fence around the football field. We're only going 3 to concern ourselves with a portion of the fence. The other math classes can deal with the remaining portions. In fact, we're only going to talk about two adjacent sections of the fence. The first section is eight feet long and it's four feet high. I thought it would be nice if we painted that part of the fence red. Red is a pretty color! Now we want to know just how many square feet of fence are we going to cover with red paint?

S: Thirty-two square feet.

T: Thirty-two square feet. How did you get that answer?

S: Four times eight.

T: Four times eight. All right, we find the area of the fence by multiplying four times eight, the height of the fence times its length. Okay, and then we have another section of fence here that is six feet long and, of course, four feet high; I thought it would be nice if we painted this part green. Now how many square feet of fence would we cover with green paint?

S: Twenty-four.

T: Twenty four. How did you get that?

S: Six times four.

T: Six times four. Okay and, oh--there's one more thing that I forgot to mention. A fence has two sides doesn't it.

S: Yes

T: Okay, so let's paint the outside of the fence white. How many square feet of fence are we going to cover with white paint?

S: Are we going to paint the whole other side?

T: Yes, we're going to paint the outside of both sections white.

S: Then we would paint 56 square feet of fence.

T: How did you get that?

S: I added 24 and 32, the areas of the two sections (i.e., $4 \cdot 6 + 4 \cdot 8$).

T: Okay, very good. Now some of you may not have liked this way of getting the total area. Is there another way of doing it?

S: Add eight and six, and multiply the sum by four (i.e., $4 (8 + 6)$).

T: All right, you added eight and six and multiplied by four to get the result, 56 square feet. Class, what do you think about these two methods? Is either one easier than the other? Will they both work?

S: Yes.

T: Okay, of course, they will. Both methods are equally effective in obtaining the area of our two sections of fence. [At this point the instructor goes through another fence analogue almost identical to the above only using sections 12' x 3' and 5' x 3'.]

T: Okay, after examining both of our results (i.e., 4 . 6 + 4 . 8 = 4 (6 + 8) and 3 . 12 + 3 . 5 = 3 (12 + 5)), do you notice any pattern here?

S: The expression on the left in each case is a sum and the expression on the right is a product.

T: Good. Also notice how the sum on the left is related to the product on the right. In the sum, we have two 4's while in the product on the right, we only have one. Suppose we have another problem, say 7 . 9 + 7 . 3. Is there another way we could write that?

S: 7 (9 + 3)

T: That's right. Suppose we have another expression, 6 . 4 + 6 . 13. What would that be equal to?

S: 6 (4 + 13)

T: Suppose we have another problem, 3 (7 + 4). What would be another way we might write that? Jim?

S: 3 . 7 + 3 . 4

T: Suppose we have another similar problem, 7 (9 + 17). Bob?

S: 7 . 9 + 7 . 17

T: Okay. Suppose we have another one, x (y + z). Chris?

S: x . y + x . z

T: Suppose that we have one more, a . b + a . c.

S: a (b + c)

T: Okay, any questions?

S: Is that the distributive property?

T: Yes it is. What is the full name of the property we have been illustrating?

S: The distributive property over addition.

T: no, not quite.

S: The distributive property of equality.

T: No. What does the property deal with?

S: Multiplication over addition.

T: Yes, it deals with two operations doesn't it--multiplication and addition. Notice that it is the only property that we have studied that deals with two operations. We have studied the commutative and associative properties of multiplication and addition, but this is the first property that we have had that links up the operations of addition and multiplication. So we have the distributive property of multiplication over addition.

CLIP 18 RUNNING TIME: 15 MINUTES CLIP LOCATION: T3 519-651

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Stating Goals and Using Historical Material

SUMMARY OF CLIP 18

This clip shows a male teacher with 12 years of experience teaching a geometry class of high ability students. The teacher's goal is to present the class with an introduction to indirect proof.

The initiating activity being attempted is the use of historical material to introduce a new topic (indirect proof); also this is another instance of where the content of the initiating activity is itself one of the goals of the lesson. The instructor gives a very brief sketch of Euclid and then spends about 15 minutes working through (with the class)

Euclid's indirect proof of the converse of the isosceles triangle theorem as found in Euclid's Elements. The converse of the isosceles triangle theorem had already been proved by the class in an earlier assignment. Another initiating activity found in this clip is a statement of the goal of the lesson. This occurs fairly early in the class period when the teacher tells the class that he is going to prove the converse of the isosceles triangle theorem the same way Euclid did in order to introduce them to a method of proof to be used in the next chapter.

QUESTIONS FOR DISCUSSION

1. Was the use of the historical initiating activity appropriate for the ability level with whom it was used? Defend your answer. Would you recommend this activity for lower level geometry classes? If not, what sort of initiating activity would you suggest using with this topic at lower levels?
2. Throughout this clip the teacher uses what may be called a directed discovery strategy, that is, through appropriate questioning, the instructor leads the class to the conclusion he wants. Do you feel that the teacher's goals could have been better served through a pure lecture approach to the initiating activity? State your reasons for believing as you do.
3. G. Polya (1957) in his book, How to Solve It, distinguishes between indirect proof and reductio ad absurdum. The teacher in this clip does not. Do you feel that the distinction is important? Explain your answer.

TRANSCRIPT OF CLIP 18

T: Now in previous work, we have already established that this is true. The teacher draws Figure 24 on the board. What is this?

$$m\angle B = m\angle C \Rightarrow AB = AC$$

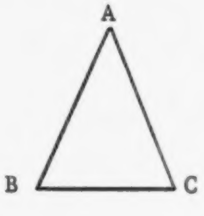


Figure 24

S: The isosceles triangle theorem.

T: The isosceles triangle theorem says what? (A student interrupts.)

S: It's the converse of the isosceles triangle theorem.

T: Right. This is the converse of the isosceles triangle theorem.
Remember, the isosceles triangle theorem states that: If two
sides of a triangle are congruent, then the angles opposite these
sides are also congruent. The person responsible for most of the 4
geometry we are studying is a man named Euclid. Euclid, as has
been mentioned before, was a Greek who lived around 300 B.C.
Euclid used a method of proof, which I will show you in just a
minute, which is a type of proof that we are going to go into
in this chapter, Chapter Six. Now he didn't waste any time in
using this type of proof. It has taken us six chapters to get
to it, but Euclid was using it by the time he got to his sixth
theorem. In his books, Euclid refers to what we would call theorems as propositions. He referred to theorems as propositions
first because he was proposing that such statements were true.
Then after he had established the propositions as true, he accepted the propositions as theorems. Now we have just gone right
ahead and said that we have theorems to prove. We've already
established this theorem [the converse of the isosceles triangle
theorem], but I'm going to prove it just the same way in which 1
Euclid did, and use his method of proof to give you an introduction to how the method of proof we're going to use in the
next chapter works. What Euclid said was, I want to establish
that segment AB is congruent to segment AC. He started his
proof by saying, Suppose they aren't. That is, suppose segment
AB is not congruent to segment AC. If this is the case, then
what does this mean?

S: Angle B is not congruent to angle C.

T: Okay, you're right in a sense; we will arrive at that conclusion later on, but such a statement now is somewhat premature.

S: It's not an isosceles triangle.

T: All right, that's one way of putting it. It's not an isosceles triangle. What does that mean in terms of the lengths of $\overline{AB}$ and $\overline{AC}$?

S: They are not equal.

T: They're not equal. Right! So what possibilities exist for the lengths? One is ______.

S: Smaller.

T: And the other is ________.

S: Larger.

[At this point, the teacher draws Figure 25 on the blackboard.

$$m\angle B = m\angle C \Longrightarrow AB = AC$$

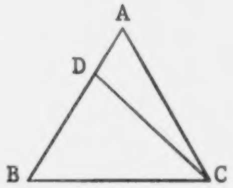


Figure 25

T: Okay, so we might have that AB is greater than AC or that AB is less than AC. Now we're going to pick one of these states of affairs. It doesn't really make any difference which one, for by picking one, we are, in effect, picking the other one also. So Euclid said, Suppose that they are not equal in length, e.g., suppose that AB is greater than AC. Then this means that we can find some point on segment AB, call it point D, where segment BD will have a length equal to AC. Now connect D with vertex C. From our given information, we know that angle B is congruent to angle BCA. Now it follows then that what must be true?

S: Triangle DBC is congruent to triangle ABC.

T: Okay, triangle DBC is congruent to triangle ABC. Now is there anything about this state of affairs that bothers you? Barb?

S: Well then BD must equal to AB.

T: Okay, we're trying to establish that, If the measure of angle B equals the measure of angle C, then AB equals AC. That's what we want to prove--the converse of the isosceles triangle theorem. Now, remember that we're proving this theorem in the same manner that Euclid did. [At this point the teacher reviews what has been established up to this point, namely, that if AB does not equal AC, then we are led to the conclusion that triangle DBC is not congruent to triangle ACB. A student interrupts.]

S: Then you've got a triangle DBC inside triangle ABC that is congruent to triangle ABC!

T: Yes! You're saying about what Euclid did. It makes you wonder doesn't it! You come down with this statement concerning the congruency of triangles, and you begin to wonder--here I've got a triangle within another triangle and they are the same size. Let me read to you what Euclid says about this result. He says this: "And, therefore, triangle DBC," and here he uses a word that we wouldn't use today, "will be equal to the triangle ACB, the less to the greater." You see this lesser triangle is equal (or congruent to) the greater. Now Euclid says that such a state of affairs is absurd. The absurdity lies in having the measure of angle ACB equal to the measure of angle DCB. By the Angle Addition Postulate and a few other things, we know that this cannot be. So where did we go wrong?

S: We went wrong in trying to cut segment AB down.

T: Right. We went wrong in saying that AB was greater than AC. We could have gone wrong in saying AC was greater than AB because we could have gone through a similar argument upon cutting down segment AC. So we went wrong in supposing that AC was not equal to AB, and that's just what Euclid said. So he reasoned that if he went wrong in saying that AC was not equal to AB, then it must be true that AC equals AB. Notice also that this is what we wanted to be true. Now this type of proof is called reductio ad absurdum, that is, reduction to the absurd. More commonly this type of proof is called indirect proof.

CLIP 19 RUNNING TIME: 3-1/2 MINUTES CLIP LOCATION: T3 END

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Using Historical Material, Giving Reasons, and
Presenting a Problematical Situation

SUMMARY OF CLIP 19

This clip shows a male teacher working with a geometry class of above average ability. The teacher has five years of teaching experience. The teacher's goal is to teach the students the meaning of the concepts of the Golden Section and the Golden Rectangle. In addition, he is trying to familiarize the students with Fibonacci numbers and how they were discovered as well as their relationship to Golden Rectangles. The topic being taught is not a normal part of the geometry course.

In this clip, there are three initiating activities illustrated. The first is found right at the beginning of the class where the instructor attempts to provide some reasons for studying the material. In the spirit of exhortation the teacher says they are going to study the material because he feels it is "very interesting and a lot of fun." The other reason given for studying the material is because it is going to be included on the next exam. This is an example of extrinsic reward.

We also find in this clip some effort being made to use historical information related to the Golden Section. The final initiating activity used is the posing of a problematical situation. This is done when the teacher asks the class, "What relationship exists between these rabbits and this rectangle?" Although not apparent in the clip, this question forms the theme around which the rest of the class discussion revolves. The question is answered near the end of the period.

QUESTIONS FOR DISCUSSION

1. As a student in the class shown in the clip, what might have been your reaction to the instructor's reasons for studying the new material?

2. Putting yourself in a teacher's role, under what circumstances is the use of (a) exhortation, (b) extrinsic reward as means of providing reasons for studying certain material most effective in enhancing student learning?

3. How might the teacher have improved the historical initiating activity? Give specific suggestions.

4. Do you feel that the problematical situation was effective in arousing the student's attention and interest in the lesson? Why?

TRANSCRIPT OF CLIP 19

T: What I would like to do today is to tell you a little something about a topic which I feel is very interesting and a lot of fun. 6

It's one that has a lot of applications in math, that is, it occurs in many different places. I hope you'll find it fun too. Unfortunately, we're only going to have time to scratch the surface of this topic, but at least you'll get an idea of its nature. The second reason we're studying it is because this material will be on the next test that you have.

The concept that we're going to discuss is quite old. It was 4
discovered by the ancient Greeks several centuries before Christ was born. The Greeks made a conscious use of this concept in their art work, that is, in some paintings they did, they made use of it in their sculpture and in their architecture. If any of you have seen pictures of the Parthenon, you may be interested to know that this whole building was designed with this concept in mind. So the concept was very prevalent in the ancient world. In addition, however, some modern-day artists have made use of it. For example, Seurat has made use of this concept in a number of his paintings.

To lead us into a discussion of this topic, consider the follow- 7
ing problem. The question that I have is this. [At this point the teacher draws Figure 26 on the board. He also writes on the board the question, "What relationship exists between these rabbits and this rectangle?"]

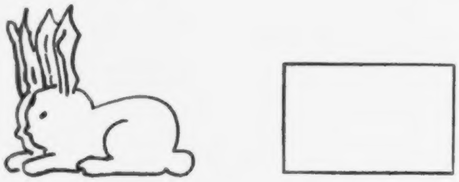


Figure 26

What relationship exists between these rabbits (and I should tell you that one of them is a boy rabbit and the other is a girl rabbit) and this rectangle? Well, before we can answer this, it is necessary for us to talk about one of the concepts I was telling you about earlier. This concept is called the "Golden Section." Have any of you ever heard of this? The students indicate no. Well, just what is the Golden Section? To answer this, I'll give you a definition of what it is. [From here on the teacher launches into a discussion of the Golden Section and the Golden Rectangle. The question relating rabbits and rectangles is resolved before the end of the period.]

CLIP 20 RUNNING TIME: 9 MINUTES CLIP LOCATION: TTT 17

INITIATING ACTIVITIES ILLUSTRATED IN THIS CLIP:
Reviewing Subordinate Information and Giving Reasons

SUMMARY OF CLIP 20

In this clip, we see a male teacher with 14 years of teaching experience working with an accelerated second year algebra class of sophomores. The teacher's major objective is to teach students how to graph quadratic functions.

The teacher is attempting to make use of two initiating activities. The first begins almost immediately in the class period when he begins to go through with the students the mechanics of transforming a quadratic function into the form $y = a(x - h)^2 + k$ by completing the square. He also reviews with the students what information can be derived by inspecting the function in this form. The second use of an initiating activity occurs later in the period. The teacher in discussing what happens when an object is thrown in the air is trying to provide the students with a reason for studying equations and graphs of parabolas.

QUESTIONS FOR DISCUSSION

1. Do you feel that the class was too teacher centered? Explain why or why not. If it were too teacher centered, what changes in procedure would you recommend?
2. Does this clip provide a good example of the initiating activity, Reviewing Subordinate Information? State your reasons for answering as you do.
3. Did you feel that the instructor made clear to the students his purpose in working through the practical application? If not, how would you have clarified it?

4. Suppose you were assigned to teach the students in the clip how to graph quadratic functions. Describe in some detail what initiating activities you would use.

5. What physical apparatus can you think of that could be used for studying a unit on conic sections?

TRANSCRIPT OF CLIP 20

T: Yesterday I spent some time putting this equation [the teacher writes $y = ax^2 + bx + c$ on the board] into this form, $y = a(x - h)^2 + k$. What was the reason for putting it into this form? 5

S: To find the vertex.

T: The vertex of what?

S: The hyperbola.

T: Okay, it's not a hyperbola but a _____.

S: Parabola.

T: Yes, a parabola. Okay, what gives me the vertex?

S: h, k

T: All right, the ordered pair (h,k) gives me the vertex. What else can I determine from that equation, i.e., $y - a(x - h)^2 + k$?

S: Whether it goes up or down.

T: All right, whether it goes up or down. What will tell me that?

S: The a value.

T: Okay, in this case, what's a?

S: a is greater than zero.

T: Right. What about the value of a if the parabola turns down?

S: Then a will be less than zero.

T: All right. This part here [the teacher points to the a in the equation $y = a(x - h)^2 + k$] will tell you whether it opens up or down. The h, k will give you the vertex. What else? One more thing.

S: We can find the parabolas' axis of symmetry.

T: Right. What is the equation of the axis of symmetry?

S: $x = h$

T: All right, $x = h$. Okay, well this we all covered in class yesterday, axis of symmetry, vertex and the value of a telling us whether the curve opens up or down. But in order to actually draw the curve, we still have to plot a couple of points. For instance let's suppose we have a point here. [The teacher places the point labeled A on the blackboard in the position shown in Figure 27.] Where can we find another point?

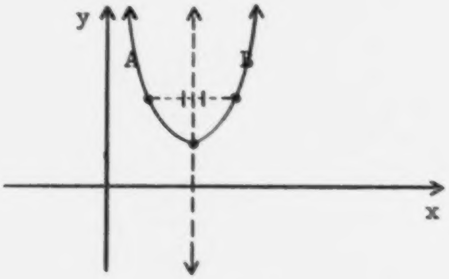


Figure 27

S: On the opposite side of the axis of symmetry. [The teacher places the point labeled B on the board and sketches the rest of the parabola. At this point in the class discussion, the teacher works through, on the board, another problem dealing with transferring the equation of a parabola into standard from. The equation he uses as an example is $y = x^2 + 2x$. He then assigns two similar problems ($y = 3x^2 - 6x$, $y = -x^2 + 3x - 2$) out of the textbook for the students to do at their seats. After going through the assigned problem, the teacher directs the student's attention to a "practical application" type problem in an attempt to provide some justification (or reason) for studying about parabolas.]

T: On page 361 I'd like to illustrate a situation or a practical
application of what we're doing here. In other words, what value 6
is there in being able to graph parabolas and put them in standard form. For instance, if you throw something into the air, it goes up and comes down. You might be interested in how long it takes the object to reach its maximum height. If you look at problem 5 on page 361, that's really what is involved. Now they tell you what formula is to be used to describe the height of the object as a function of the time that it is in the air. The formula is, $h = 20 + 128t - 16t^2$.

S: Where did they get that formula?

T: Well, somebody has done some mathematics and figured out the formula. The formula is not just one that the authors made up. It's used in physics to compute the height of a projectile. So, you've been given the formula. By the way, what does the graph of this look like? Isn't it second degree also? Isn't it a quadratic function? So the graph of it is going to be some kind of a parabola. Let's graph it. First, put in in descending powers of t. Now the numbers aren't too nice. Multiply through by a 1/16th. [At this point the teacher places the equation of the parabola in standard from for the students.] The vertex is (4, 276). What's another point I could quickly graph? Well, if we let t = 0, you get a point here, 20. So we see that this is a very narrow parabola. Now remember we said that the vertex had coordinates of 4 and 276. What do these numbers tell us? In other words what was the purpose of this problem? Well, it was to find two things, to find the height--and what is that?

S: 276

T: Right, 276. Another question was, how long does it take it to get there? Recall that the horizontal axis is the t-axis.

S: Four seconds.

T: Good, so we have here an illustration, where by graphing or by completing the square, we can determine the maximum height of a projectile along with the time it takes for it to reach its maximum height. Are there any questions on this?

CHAPTER FOUR

USE OF VIDEO-TAPES

This chapter is divided into two sections each of which relates to activities involving the actual use of the video-tape clips with twelve student teachers in mathematics. These students represented about one-half of the enrollment of a methods class for mathematics teachers at the University of Illinois offered during the Spring semester of 1972. None of the students had yet done his student teaching. The twelve students, along with the investigator, met four hours a week for four weeks and for two hours during the fifth week of instruction.

Since this investigator was unable to find any precedent in the literature for using materials such as those developed in this dissertation[5], there was no model or recommended way to utilize them with pre-service teachers. One of the objectives of this thesis was, in fact, to gather some ideas for using these materials with such teachers. The following two sections describe how the investigator decided to conduct the training sessions.

Orientation

The first four hours of instruction were devoted to familiarizing the students with the seven initiating activities which have already been identified in Chapter Two. On the first day, a five-minute video-tape was shown. It showed four different ways that a mathematics teacher might begin his class.[6] This tape served very well to focus the student teachers' attentions on what would be the major emphasis during the five weeks of training, namely, how they begin their lessons. The tape was also useful in pointing out some reasons why teachers need to be concerned with initiating activities.

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[5] The investigator learned, after conducting the training sessions, of the extensive Video-Tape Project at Carleton College in Northfield, Minnesota. The materials being developed in Carleton's project are of a similar nature to those developed in this dissertation.

Teaching as an art was briefly discussed. A quantum approach to teaching was then explained. That is, the students were asked to conceptualize the teaching act as the performance of a number of different activities, such as initiating activities, reinforcement activities, homework assigning activities, etc. The students were then told what the main focus of the training sessions would be--a consideration of some of the ways available for beginning the study of lessons in mathematics.

A written definition of what would be meant by initiating activity (see page 5) was given to the students along with five general goals of the training sessions. These goals are listed below.

1. Define, exemplify and suggest for possible use at least seven different initiating activities.
2. View and discuss the use of initiating activities by real teachers in high school classes.

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[6] These four beginnings were staged in a television studio with no students present. The first showed a teacher beginning class by perfunctorily dictating answers to the previous night's homework. The second had a teacher beginning to write on the board precisely where he had left off on the previous day's lecture. The third showed a teacher starting class by telling the students how boring and useless the material was that they were going to study. The last clip showed a teacher quieting a noisy class by removing a six-shooter from his desk and firing two blanks into the air.

3. Help the participants reach the point in their own lesson planning where they will give some conscious thought to how they are going to begin the study of new material.
4. Gain practice in planning for and actually using initiating activities in the teaching of mathematics in a micro-teaching setting.
5. Help the participants to reach the point in their professional development where they can, without being threatened, look at a video-tape of their teaching performance in an honest attempt to identify those behaviors (especially initiating activities) that can be changed in a manner that would presumably enhance learning.

Both the definition and the goals were discussed in some detail. The seven initiating activities were then revealed to the student teachers and each was explained and illustrated by oral examples. Video-tape clips illustrating each of them were also presented. Each clip was followed by a discussion of the initiating activities being used. The summaries and questions relating to each clip and presented in Chapter Three were used as guides in the discussions.

The final item of business at the first session was to define clearly for the students what their first micro-teaching assignment was. Briefly, they were told to prepare a ten-minute lesson on a topic of their choice. The lesson was to be appropriate for high school mathematics students, and they were to give special attention to the way in which they introduced the lesson. They were to make use of any of the seven initiating activities that seemed appropriate or any others that they might think of. The students were told that their micro-teaching tapes would be viewed the following week during class with everyone participating in a discussion of the teaching in general with particular emphasis on the initiating activities used. A bibliography, deemed by the investigator as useful in planning initiating activities, was also given to each student. This bibliography is shown in Appendix C.

Format of the Training Sessions

After the first four hours of instruction, time in the training sessions was spent mostly in two different ways: (1) in looking at and discussing more of the 20 video-tape clips developed in this dissertation, and (2) in watching and discussing the video-tapes of the group members' micro-teaching presentations.

Regarding the first activity mentioned above, the procedure was usually to prepare the students for what they were going to see in the clip. This was done by either telling the students what initiating activities would be illustrated in the clip or by giving them a summary sheet describing the clip and containing discussion questions related to the activities being illustrated. These summary sheets for each of the 20 clips are, as was mentioned earlier, contained in Chapter Three. We would then view the tape. Occasionally the experimenter would stop the tape or replay a certain segment of it in order to highlight some aspect of the use of an initiating activity or some other facet of the presentation. Following the observation, we would spend some time discussing the clip. The questions served as a framework for these discussions.

The micro-teaching phase of the training sessions was carried out in the University of Illinois Teaching Techniques Laboratory. This facility consisted of several small rooms containing a wall-mounted television camera at the front and the back of each room. The student teacher presented a ten-minute lesson to a group of from four to five paid "students" (University of Illinois freshmen). A university student teaching supervisor was present during the presentation and conducted a follow-up critique session of the student teacher's performance. In addition, each paid student completed a form like the one found in Appendix E after each teaching session.

As was mentioned, the students were instructed during the orientation phase of training to prepare a ten minute lesson on some topic appropriate for high school mathematics students. They were told to give special attention to how they would introduce the topic. Each student taught three micro-lessons--one every other week. The video-tapes of these lessons (except for the final session) were carefully reviewed by the experimenter with particular attention given to the appropriateness and quality of the initiating activity used. The student evaluation forms (Appendix E) and forms similar to the video-tape identification forms (Appendix B), which were filled out by the student teachers, assisted in these evaluations. In subsequent meetings with the student teachers, as many of the ten-minute lessons as could be fitted into the available class time were viewed by the group. The students were encouraged under the guidance of the experimenter to criticize constructively their peers' usage of initiating activities as well as to make comments regarding other aspects of the presentations.

CHAPTER FIVE

EVALUATION AND DISCUSSION

The first two of the three sections in this chapter contain remarks, of an evaluative nature, relating to the production of the video-tapes developed for this thesis, the method in which the training sessions were conducted, and the effect that the training sessions had on the actual classroom behavior (relative to their use of initiating activities in beginning their lessons) of the student teachers. The third section of this chapter provides the reader with a summary of the study along with conclusions, implications and recommendations for further study.

Production of Materials

The degree of success one has in undertaking a project such as the one described in this thesis depends upon many factors. Paramount among these is the willingness of classroom teachers to cooperate. This experimenter was very fortunate. The teachers with whom he worked were most cooperative. Several spent significant amounts of their own time in preparing initiating activities for taping, and all gave generously of their time both before taping (in planning conferences) and after taping (in reviewing their video-tapes with him).

The experimenter did encounter a minor problem related to the busy schedules of most secondary teachers. He felt somewhat uneasy in asking the teachers for some of their free time to sit down with him to plan initiating activities. Only the friendly and cooperative attitude of the teachers prevented this from becoming a major obstacle in the study.

Another potential source of difficulty was related to the reviewing sessions during which the teacher and the investigator watched the video-tape of the teacher's presentation. The investigator felt that it was necessary for him to be quite cautious in making remarks concerning the teaching. He felt that it was not his place to go into a school (at his own invitation) and then proceed to conduct critique sessions. When a teacher did ask for an opinion regarding the presentation, however, he gave one. Nevertheless, such opinions were usually guarded. In addition, since this was the first time most of the people had been video-taped, the experimenter felt that just a look at themselves in action (without many comments) was often times eye-opening enough. The results of a study by Perlberg and O'Bryant (1968) lend support to the investigator's viewpoint on this matter. They write that

> Everyone who went through the procedure [the college professors who subjected themselves to video-taping] expressed some degree of anxiety about self-confrontation. In one case, a professor commented after viewing his tape, 'Gosh, this is the first time I have seen myself as others see me. I did not realize I was so boring.' Another professor viewed himself and said, 'I am not interested in more taping. This is the first and last time' [p. 18].

Despite the informality of the follow-up viewing sessions, an unsolicited letter from some of the members of the Wheeling Mathematics Department to the superintendent of their school district indicated that these sessions had caused them to rethink some of their teaching procedures. It seems to this experimenter that such a response to this project by these teachers lends support to the use of such video-tapes on an in-service basis as suggested on page 7.

Naturally when one moves video-taping equipment into a classroom, the students are going to be curious. There was some "performing" before class in front of the camera by a few of the students as well as a number of questions regarding its presence. In only about two instances, however, were students distracted by the investigator's recording of a class. If anything, the recording equipment had a sobering effect on the students. Some appeared a bit self-conscious when they thought the camera was trained on them. This seemed particularly true when a single student was speaking and he knew he was being filmed. Surely this problem could have been almost completely eliminated if the investigator had had the time and tape to allow him to spend several days in one class taping and then to let the students view themselves. Such a procedure would also accustom the instructors to the presence of the equipment and thus relieve some of the anxieties that a few of them expressed. In any event, almost all of the classes, according to later reports by the teachers, were "normal." The following comment from the Carleton Video Tape Project (referred to in the first footnote on page 5 of this dissertation) lends support to the above comments:

> The Video Tape Project has accumulated a great deal of personal testimony and other evidence that subjects soon forget they are being video taped; consequently, it is believed that the content obtained by this method is as similar to regular classroom activity as it is presently possible to capture [Carleton College, 1971, p. 3].

Although Appendix A contains a list of the hardware used in taping the classes, several comments regarding its use seem in order. In general the equipment was very satisfactory. The good quality of the picture (which is essential for a project such as this which involves editing of the original video-tapes) was achieved under the normal fluorescent lighting conditions of the classrooms used. Naturally, the picture quality would have been improved if high intensity lighting had been used. To use such lighting, however, would have destroyed some of the natural classroom atmosphere that this experimenter was striving to achieve. On one occasion, the experimenter was even able to tape satisfactorily a slide presentation done in a room with all of the lights out. Naturally the students and the teacher were barely visible, but the slides themselves showed up quite well. As it turned out, the edited tapes were of almost the same quality as the originals.

The major undesirable feature of the Ampex, one-inch video-tape recorder used was that it was rather noisy. While not a serious problem, this noise, for those sitting near the machine, made it somewhat difficult to hear the teacher at times. In addition, the microphones picked up the sound of the machine, thus recording it. In larger classrooms than those in which this investigation was done, this would probably not have been a problem at all.

Use of a zoom lens, although not essential, is certainly desirable. Without it, boardwork and writing on an overhead projector is impossible to read unless the camera is very close to the writing. Also, use of such a lens allows one to study the facial expressions of various individuals.

Being able to record well the remarks of all students as well as the teacher's was the biggest technical problem. The most satisfactory all-around results were obtained using four microphones arranged as shown in Figure 32 in Appendix A. Even with this arrangement, however, if the students and teacher did not speak up, sound recording remained a problem. An arrangement that was not tried but that may be more effective than the one just described would be to have the teacher use a lavalier. Three other microphones could then be suspended from the ceiling and directed toward the students.

The only other significant problem that the experimenter had with the equipment was in actually operating the camera. It took a fair amount of practice to learn how to coordinate the aiming of the camera (here one needs to keep one eye on the teacher and the other on the students so as to take advantage of any interesting student responses), the movement and simultaneous focusing of the zoom lens and the continual adjustment of the audio- and video-level meters on the videotape recorder. Practice in using the equipment in classroom situations is recommended before attempting actual taping.

The Training Sessions

The content of this section relates to the second objective of this thesis as found on page 6 . For convenience, this objective is restated here: The second objective of this thesis is to appraise the effectiveness of the materials (which were developed in meeting the first objective) in training sessions with student teachers. The purposes of the training sessions are (1) to see whether the sessions have any observable effects on the way in which student teachers initiate their lessons in mathematics when they get in the field, and (2) to use the comments and suggestions originating in these sessions as a basis for revising the training materials and the way in which they are used in future training sessions.

Observable Effects

The supervisors' reports. Two means were used in attempting to ascertain whether the sessions had any effect on the way in which the student teachers performed in the classroom. The first involved having three university student teaching supervisors (in mathematics) complete observation forms (shown in Appendix D) on each of the student teachers they visited during the six-week student teaching experience. The investigator's plan was then to compare the write-ups of how the teachers began their lessons. Both the number and the manner in which the activities were performed by the students who had been a part of the training sessions would be compared to those used by the student teachers who had not been a part of the training sessions.

While this procedure appears on the surface rather straight forward, hindsight revealed a number of shortcomings which made the observation reports that were received from the supervisors less helpful than they could have been. First, it became apparent to the investigator that he probably should have spent more time in familiarizing the supervisors with the seven initiating activities. In doing this, it would have been most advantageous to have given the three supervisors training comparable to that received by the student teachers. As a part of this training, the supervisors could have had each of the initiating activities explained in some detail and could also have been shown some of the video-tapes which illustrated each of the activities. Presumably, this approach would have better prepared the three supervisors for their task, which was to look for and describe the initiating activities used by the various student teachers as well as to make a judgment concerning the manner in which the activities were performed. In the procedure actually used, however, the investigator met very briefly with each of the supervisors. During the three meetings, the experimenter discussed his project, described quite succinctly each activity and explained how he wanted the observation forms (see Appendix D) used.

A second shortcoming concerned the interpretation of the completed observation forms received from the three supervisors. The investigator found it quite difficult in some instances to ascertain whether, in fact, an initiating activity was being used. Even when it was clear that some activity had been used, it was almost impossible for him to make any sort of judgment concerning the manner in which the initiating activity was performed. The experimenter felt that part of this problem could have been overcome had a more intensive training session been conducted with the supervisors in the manner suggested in the previous paragraph. If the supervisors had been better informed about the initiating activities, and if they had been given more opportunity to discuss them, it seems reasonable to suppose that the information supplied to the experimenter would have been easier to interpret.

A final shortcoming of using the supervisor's observations concerned the frequency of the observations. In all, there were 27 student teachers in mathematics. The three supervisors were responsible for 26 of these.[7] Only three of these students were observed three times.

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[7] The 27th student teacher (who happened to be a member of the training sessions group) was, for administrative reasons, supervised by another supervisor whose major area of interest was not mathematics. No observation reports were completed on this student.

All of the others were only seen in action twice during the six-week teaching experience. Hence, even though some student teachers may have tried using various initiating activities, the probability that a supervisor would be observing on the day the teacher used it was quite small. That this situation did occur in at least one instance was revealed to the experimenter in a telephone conversation with one of the student teachers in the training group. The student indicated that he had tried using initiating activities on a couple of occasions. The supervisor's observation form on this student, however, revealed no such use. In addition, as the following section reveals, almost all of the students in the training group admitted to having used some initiating activities during their teaching experience. Despite this, the supervisor's observation forms showed only a small number of these students using them.

As Table 4 shows, of the 55 observations made by the supervisors, only 12 revealed any attempt on the part of the student teachers at using initiating activities. Furthermore, only five of these twelve were done by students who were involved in the training. In addition, only one of these twelve initiating activities was rated as being superior by the supervisor; this was done by a student not exposed to the training sessions. It should also be noted that in no case was there a report of an analogue or of historical information being used to initiate a lesson.

It is also interesting to note in Table 4 the percentage of observation reports which revealed attempts at using initiating activities. Five out of 21, or about 24%, of the observations made on those students in the training group showed attempts at using initiating activities. Seven of 34, or about 20%, of those observations on the students who were not exposed to the training sessions showed attempts at using initiating activities. Due to the informal nature of the study, of course, no definitive conclusions can be drawn from these data. The data do, however, tend to confirm the experimenter's belief that there is a need in teacher training programs for emphasizing various ways of beginning lessons.

Table 4

Summary of the Supervisors' Observations

	Observations showing a use of initiating activities	Observations showing no use of initiating activities	Totals
Student teachers who were part of the training sessions (12)*	5	16	21
Student teachers who were not part of the training sessions (15)	7	27	34
Totals	12	43	55

*As mentioned, one of the student teachers in this group was not observed by any of the three supervisors.

The student teachers' self analyses. The second means of ascertaining the student teachers' behaviors was to have them answer the following questions: (A) What initiating activities did you use in your teaching? (B) Do you feel that the training sessions caused you to think about the way in which you planned your lessons? Comment. Written answers to these questions were supplied to the experimenter during a two hour meeting following completion of the six-week student teaching experience. Nine of the original 12 students attended this meeting. Of the remaining three, one was ill and the other two were interviewing for jobs.

In response to question (A), all but one of the students indicated that they had used from two to five different initiating activities on various occasions. Two of those who did indicate that they had used these activities, however, admitted that their use was either not intentional or not as frequent as it could have been. The one student who confessed to not using any initiating activities explained his neglect by pointing out that his cooperating teacher virtually forced him to conduct class in the same manner every day. That is, the student teacher was required to begin class by writing the answers to the previous night's homework problems on the board, allow students time to check them, circulate through the room checking work, make the next day's assignment and allow some class time for study. Such a restrictive routine, he argued, was not conducive to the use of initiating activities.

An interesting comment arose during the final two-hour session with the student teachers. One of them indicated that "Outlining" which during our training sessions had appeared to him as a very trivial sort of activity turned out to be one that he found his students most appreciated. In fact, he went so far as to say (somewhat facetiously) that his students almost asked him to use this activity. Another student teacher indicated a similar experience. Both said that the high school students greatly appreciated knowing where they were during a particular lesson. The outline apparently served as sort of a roadmap for them.

The second question (B) elicited a variety of responses most of which supported at least some study of initiating activities for student teachers. All nine of the answers to this question were rather brief and are listed below. The question was, "Do you feel that the training sessions caused you to think about the way in which you planned your lessons? Comment."

1. Not a great deal--mainly because of the situation I was placed in with my cooperating teacher. She practically told me how to do every lesson which doesn't allow for much creativity.

2. The fact that I was restricted really made me think about how I would have done it [that is, initiated the lesson] had I been able to, because frankly I was bored to tears by beginning the lesson the same way every day.

3. Not really. My problem was not their initial interest but rather their continued interest. This may sound bizarre since how can one have continued interest without first having the initial interest. It is not bizarre however. My students would pay attention easily to see what was going to be done. I think the topic of initiating activities encompasses an entire presentation or lesson . . .

4. Yes . . . I do think a unit on initiating activities has a place in a methods course.

5. Yes the training sessions caused me to be more aware of how I should approach a lesson. I looked at most lessons trying to find an interesting different approach to introducing the subject. (Many times I found it quite difficult to do.)

6. Yes, but I'm afraid I didn't use it as profitably as I could have . . .

7. Yes, the micro-teaching was especially helpful, in that it made me realize that my lesson plans need to be somewhat detailed. Emphasis on initiating activities also made me think about the best ways to present . . . material when I got out and really had to start doing it.

8. Yes, to a certain extent. Not only the initiating activities but also the other discussions and films helped.

9. Yes, to some degree. I wasn't overboard on thinking about initiating activities, but initiating activities sort of gave me a foundation on which to build a lesson.

Students' Comments and Suggestions for Future Use

As was stated earlier, the experimenter could find no precedent in the literature for using video-tape materials of the type developed in this study. As a result, he used what he felt would be an effective training format in a micro-teaching setting. The reader will find this training format described in the section entitled, Format of the Training Sessions, on page 124.

In an attempt to achieve the second part of the second objective of this dissertation (which was to use the comments and suggestions originating in these sessions as a basis for revising the training materials and the way in which they are used in future training sessions), the investigator asked the 12 participants to answer four questions. The anonymous written answers to these questions were collected during the final two-hour session held with the student teachers before they went out to do their student teaching. Below are listed the four questions:

1. Do you believe that the time spent in discussing the use of initiating activities during these past five weeks was generally worthwhile? Tell why or why not.

2. Would the past five weeks of training sessions have been as meaningful to you if NO use had been made of the video-tapes of (1) the real teachers, (2) the micro-teaching episodes? Tell why or why not.
3. Do you believe that your participation in these training sessions will affect the way in which you plan your lessons when you are teaching? Comment.
4. For future use, what changes would you recommend for conducting the class sessions? Be as specific as you can and do not pull any punches.

The student teachers' perceptions of the training sessions. In what follows, the experimenter will attempt to summarize the students' answers to each of the four questions.

Question 1: Do you believe that the time spent in discussing the use of initiating activities during these past five weeks was generally worthwhile? Tell why or why not.

The unanimous response to this question was that the time spent in discussing the use of initiating activities was worthwhile. Some of the students, however, did have some reservations about the amount of time spent in looking at the various activities. This feeling is conveyed in the following remarks by some of the students:

> Discussing the use of initiating activities was generally worthwhile. I don't think we should have spent four hours each week watching the video-tapes, especially at the beginning of the semester before we got to watch our own [micro-teaching tapes].

Another wrote,

> I feel that the topic of initiating activities is very worthwhile, however, it seemed as if it could have been covered just a little more rapidly.

Finally a student says,

> Generally, I think it was worthwhile. There were times, however, when watching two hours of video-tape was too much. It began to get a little dull.

The following remarks are from some of the students who expressed very positive feelings regarding the time spent in discussing the seven activities:

> The time spent in discussing the use of initiating activities has been generally worthwhile . . . It is easy to get into a set pattern in teaching, but by recalling the seven different activities each of us should be able to present a diversified lesson often.

Another student writes,

> By trying to introduce topics in the micro-lab, one quickly realizes that the idea of initiating activities is not something which should be pushed aside. It takes as much or more effort than the rest of the lesson. Personally, I am glad we have spent time on it.

We find another student teacher saying,

> Yes. The discussions caused us to really have to think about ways we could use the initiating activities. It was also helpful in that we considered various approaches to individual topics; and we thought about different situations in which one initiating activity would be better than another. The emphasis upon the teacher considering his/her individual personality and the teacher's relation to the class in question in choosing initiating activities was worthwhile.

The last student to be quoted was rather emphatic in stating,

> Absolutely yes! I think that the start of the lesson is one of the most important parts of the lesson. Many times if a teacher can get the lesson (chapter or unit) off on a good foot, half the battle is won; that is, the students will really be interested (and sometimes even excited) in the lesson. Therefore, it is well worth the time to go into detail about the various ways of using initiating activities.

Question 2: Would the past five weeks of training sessions have been as meaningful to you if NO use had been made of the video-tapes of (1) the real teachers, (2) the micro-teaching episodes? Tell why or why not.

The responses to this question were not so easy to summarize. In general, it is accurate to say that the students favored the use of video-tapes during the training sessions. Opinions varied, however, concerning which tapes (those of the real teachers or those of the micro-teaching sessions) were of most value. Below are excerpts from the answers to question 2 from five students who felt that the tapes of the real teachers were of more value than the tapes of the micro-teaching episodes. One student said simply, "I liked the video-tapes of the real teachers, possibly because they were in 'real' situations." Another student commented,

> I feel that the training sessions would have been as valuable without showing the micro-teaching episodes. The video-tapes of the real teachers were interesting and evoked some good discussions. The people in the class did not have to guard their remarks and I feel that this was much more valuable than the micro-teaching tapes.

A similar reaction was expressed by another student who wrote,

> The past five weeks of training sessions would have been more meaningful if we had seen tapes of what should be done--not what should not be done. The micro-teaching episodes which were bad could have been discussed but not viewed. Stress positive ideas instead of what not to do.
>
> The real teacher tapes were good in comparison to the micro-tapes because micro-teaching is such a limiting situation.

One student, not enamored with our procedure for discussing the micro-teaching video-tapes, said,

> Use of the videotapes of real teachers to me seemed useful because it gave us examples of the use of initiating activities in class. However going over everyone's micro-teaching lesson to me seemed a waste of time.

Finally, a student answered the question by remarking,

> I think that for the most part video-tapes of the real teachers were quite valuable. . . . I think that the tapes

> where the teachers had novel methods of presentation were particularly good. Therefore, if no use of these tapes were made, I do not think the five weeks would have been as meaningful.

Comments from four other student teachers who found the viewing of the micro-teaching tapes of their peers to be of greater value are listed below.

1. . . . It was especially useful to me to see myself teaching a class--so I could easily recognize my shortcomings and work to improve my techniques.
2. . . . And the videotapes of the microteaching episodes . . . helped me to see how effectively some of the things we discussed could be used and how even good ideas can be botched up.
3. The video-tapes of the real teachers were not as interesting as those done by fellow students in the micro-teaching lab. The video-tapes in general were definitely helpful in the training sessions. The only problem was that we saw so many and we got tired of re-hashing them after every clip.
4. The videotapes of the teachers seemed of little value. Nothing really sticks in my mind as being important after watching them. They were, for the most part, either ridiculous or somewhat like teachers we've been seeing as students for the past 16 years. The tapes of ourselves were helpful. It's interesting to see the approach of fellow students; people who are under the same situation as myself. Most helpful was seeing myself in action--or the lack of it.

Question 3: Do you believe that your participation in these training sessions will affect the way in which you plan your lessons when you are teaching? Comment.

The students were unanimous in their agreement that the training sessions would affect the manner in which they prepared their lessons while in the field. Once again, a listing of some of the answers given to this question will best expose their feelings to the reader.

1. Certainly I am very conscious of initiating activities now. I look for them in my other classes, and when I . . . consider how to teach a certain topic my first attention is to how to introduce it. This is not entirely due to this class, but my work is much more organized now.

2. Yes. I'll think a little more about trying to make things more interesting for the students. The 'go over yesterday's homework,' 'talk about today's lesson,' 'assign tomorrow's homework' bit is really a drag.

3. Yes. I think that one of the first things I will consider when planning a lesson will be 'How can I start this lesson in an interesting and "exciting" way?' The list of seven initiating activities will help as far as suggestions and methods of variation.

4. These sessions will definitely affect the lesson plans I make. I realize that monotony is horrible and these different initiating activities bring variety into the classroom. Planning an initiating activity also helps, I think, to get the teacher more enthusiastic about the lesson which is very valuable.

An analysis of the responses to the second question (question B) given on page 135 revealed that over fifty percent of the student teachers agreed (after completing student teaching) that the training sessions had, in fact, affected their lesson planning.

Question 4: For future use, what changes would you recommend for conducting the class sessions? Be as specific as you can and do not pull any punches.

In responding to this question, the student teachers provided the investigator with a number of good suggestions for improving the training program. One suggestion was that perhaps too much time was spent in discussing the micro-teaching video-tapes. Several persons expressed this same point in one way or another. As one student put it,

> Class sessions could be improved with the elimination of the class review of each person's micro-teaching lessons and more ideas about different approaches on the introduction of

> . . . [lessons] . . . I feel that this topic [presumably the whole topic of initiating activities] could have been covered in a portion of the time that was allocated for it.

Several people also suggested the possibility of having all class members present live lessons to the group. This procedure would have the advantage of immediate, on-the-spot critiques of the initiating activities used. One student who suggested this wrote, "This way we all could try each of the 7 kinds and get more experience in actually making them work." This same student also remarked that "More of the methods class should be devoted to specific skills such as this."

Another student suggested that the investigator "Present more material than just tapes--perhaps you [the investigator] could teach us a math lesson--[to] see if we would be interested."

Two students were quite supportive of the format and content of the training sessions. Their comments are enumerated below.

1. The class sessions were pretty good. Each teacher needs the opportunity to tell what his hang-ups are. Viewing ourselves and others may be somewhat uncomfortable, but it is worthwhile.

2. It's too bad this course is so short . . . with what little time we did have, I thought the class sessions were very valuable. I especially liked the video-tapes. It's much more effective to watch someone doing something than to just talk about it. I can't think of any real changes in the . . . [training sessions].

Summary, Conclusions, Implications and Recommendations for Further Study

Summary

The original motivation for this thesis topic arose out of the investigator's perceived inadequacy as a college supervisor of student teachers. During the follow-up conferences held with the student teachers after observing them teach a class, the investigator frequently was at a loss as to what to say to the student teachers. Usually the remarks he made were of a very general nature, and, in his opinion, of limited value to the student. As the section entitled, Some Inadequacies of Teacher Education Programs, revealed (see page 1), other teacher educators shared the experimenter's opinion.

The objectives of this thesis centered around the development of materials related to one aspect of teaching which the investigator, as well as others, considered of much importance in the typical classroom teaching situation, namely, "How can mathematics teachers begin their lessons?" The development of such materials, it was felt, would be an important step in providing both student teacher supervisors and their charges with information which could serve as a focus about which supervisory conferences could be built. In Chapter Two, seven such ways of initiating lessons were described. Rationales and written examples for each of the so-called initiating activities were also given. Videotapes showing high school teachers working in actual classrooms and illustrating each of the initiating activities were produced and formed an important part of this dissertation (see footnote 1 on page 5). The investigator's hope was to develop some teacher training materials that would be useful in a variety of settings, some of which were listed on page 7.

Chapter Four described the investigator's attempt at using the materials in an actual pre-service methods course conducted with twelve student teachers in mathematics. The training sessions were quite informal. No attempt was made to conduct a tightly controlled experiment. Since there was no precedent for using the type of materials developed in this thesis, the primary purpose of the training sessions was merely to get some experience in using the materials and to solicit the students' reactions to their use.

Conclusions

The conclusions of this study are divided into two major categories. First, some conclusions regarding the actual development of the video-tapes will be presented. Following this will be some conclusions related to the operation of the training sessions.

As was mentioned in the section entitled, Production of Materials, on page 126, the experimenter was generally pleased with the quality of the video-tapes (the word "quality" here refers to the technical quality of the tapes and not to the quality of the initiating activities being illustrated). In future tapings of real classes, however, the investigator would recommend using a one-half inch video-tape recorder. The reason for this is primarily one of economics. One-inch, sixty-minute video-tapes cost about $49.00 compared to about $33.00 for a one-half inch tape of the same length. Also, one-half inch tapes and recorders are in general easier to handle than one-inch equipment.

The investigator also discovered that there was a fairly serious disadvantage in attempting to get unstaged examples of the various initiating activities. The disadvantage was that in going into the real classroom as he did, he was forced to work with the teachers where they were in a particular course. That is, some topics in mathematics were more conducive to the development of "good" initiating activities than were others. If a teacher happened to be covering one of these less productive topics, then the experimenter was just out of luck. Such a disadvantage made a strong case for the studio production of the video-tapes. Of course, the problem could have been lessened by spending a longer time in the schools or working with a larger number of schools.

As a result of his experience in using the video-tapes with the student teachers, the investigator, in developing additional illustrative clips, would strive to keep the length of the clip under about six minutes. Doing so would hopefully have relieved some of the boredom that a few of the students said they experienced in watching the clips. It would also allow viewing a larger number of teachers in a fixed length of time.

In regard to the actual use of the training materials (the video-tapes of the real teachers along with the discussion questions on each clip), several conclusions were reached. First, after listening to the audio recordings of all of the training sessions, the investigator discovered that much of what was discussed in these sessions did not deal with initiating activities but other aspects of the teaching performance as well. While this is not in itself bad (and in a number of cases led to some profitable discussions), in future sessions of this sort where the primary emphasis is on training student teachers in the use of initiating activities, the experimenter would attempt to concentrate the discussions more on the use of such activities and not get off on so many tangents. This procedure would hopefully result in greater efforts on the parts of the student teachers to make use of initiating activities in their teaching.

The experimenter felt that the micro-teaching component of the training sessions offered a very good medium in which to study initiating activities. Giving students an opportunity to try using such activities after we had discussed them made a lot of sense. The experimenter definitely agreed with some of the students who felt that too much class time was spent in viewing the video-tapes of their peers. In the future, he would limit the discussions of the micro-teaching tapes to only the initiating activities that were attempted and to how they might be improved. This conclusion seemed to support the conclusions of studies done at Stanford University where micro-teaching was first developed. Referring to the playback of micro-teaching video-tapes, Schuck (1971) writes,

> The staff at Stanford is convinced that the most inefficient use of the videotape is to replay the entire lesson and just sit and watch it. The supervisor needs to point out the specific things (not more than one or two) on which he wants the intern to focus. He needs to replay small segments to emphasize or clarify certain points [p. 40].

As has already been mentioned on page 132, the attempt to compare the number and quality of initiating activities used by students in the training sessions group to those students not in this group was not completely successful. Future attempts at such an analysis could probably be handled better by (A) requiring all of the student teachers to turn in, say twice a week, detailed lesson plans or (B) having the university supervisors audio-tape the classes they observe.

Despite the shortcomings of this investigation, some of which through the benefit of hindsight now seem rather obvious, the experimenter is quite encouraged by what he has done in this dissertation.

For, although far from perfect, the video-tape clips and discussion questions have shown themselves as having a lot of potential utility in a pre-service methods course as well as on an in-service basis.[8] In addition, he has been encouraged by the general reactions of the student teachers to a study of initiating activities.

Implications and Recommendations for Further Study

This thesis suggests a number of possible areas of investigation. For one thing, initiating activities are only one of a number of activities that teachers perform in teaching (see page 4 for some others). Developing video-tape examples of the use of these other activities is a worthwhile undertaking. In addition, this dissertation has definitely not explored all that can be done with initiating activities. An enlargement of the listing of such activities could be done along with the enlargement and improvement of the repertoire of video-tape clips illustrating each.

This study has only explored the use of the video-tape materials with pre-service teachers. In addition, this was done using a very small number of teachers, using a loosely structured training format and where micro-teaching facilities were available. Other methods of using the materials need to be examined. For example, using the video-tapes with pre-service teachers where no micro-teaching facilities are available, or discussing the various initiating activities without the benefit of the video-tapes but, instead, using only the transcripts (see Chapter Three). Also the usefulness of such materials as those developed in this study with college supervisors and with teachers on an in-service basis needs examination.

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[8] It should also be noted that one educational psychology instructor at the University of Illinois who saw the tapes considered them of much value. She used them in her courses to illustrate the use (or lack of use) of psychological principles in actual classroom settings.

Some studies are also needed that would explore whether or not the use of initiating activities (as defined in this thesis) is worthwhile. That is, such questions as the following need study: Do students who are taught by teachers who make use of initiating activities achieve better than students whose teachers do not use these activities? Are the teachers who use initiating activities perceived by their students as being better teachers than those who do not use such activities?

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APPENDIX A

A LIST OF THE HARDWARE USED IN RECORDING

1 Ampex VR-5100 1" video-tape recorder
1 Sony video monitor
3 RCA microphones with stands
1 RCA lavalier microphone
1 audio mixer
1 Concord TCM-20 television camera with viewfinder and tripod
1 Cannon zoom lens (8 to 1 zoom ratio)
assorted cables and power cords

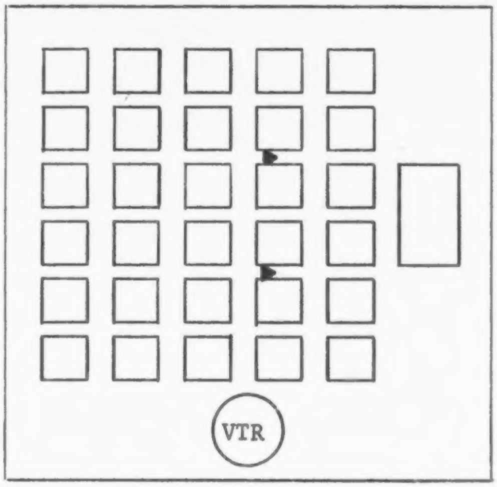

Figure 30. In this configuration, two floor mikes were positioned as shown at the left and were directed toward the teacher.

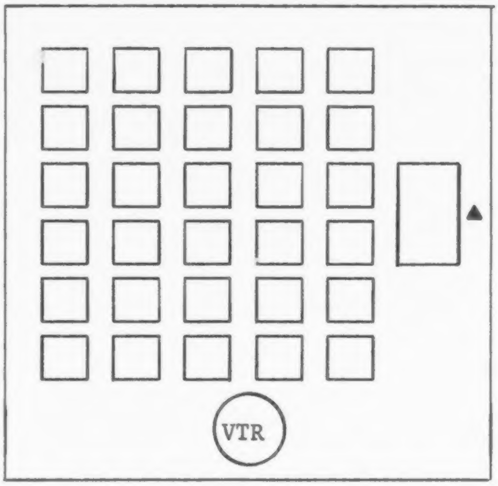

Figure 31. In this arrangement, the teacher used a lavalier mike.

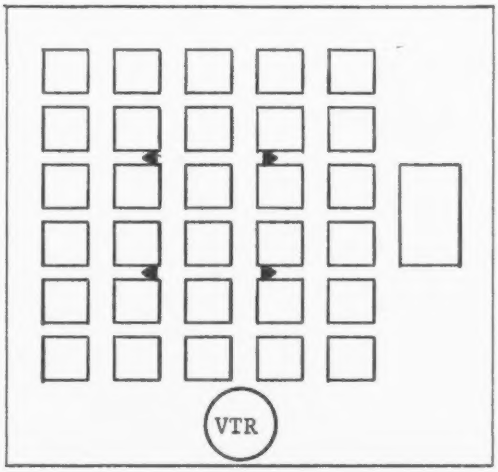

Figure 32. In this arrangement, four microphones are suspended from the ceiling in the approximate positions shown. The front two are directed toward the teacher with the back two toward the class.

APPENDIX B

VIDEO-TAPE IDENTIFICATION FORM

1. Name of the teacher:______________________________

2. Date of taping: ______________________

3. Number of years of teaching experience: _______________

4. Name of subject being taught: ________________________________

5. Textbook used (author, title):__________________________________

6. Grade level of the students: ____________________

7. Approximate ability level of the class:
   (low ability, average, high ability) ____________________

8. Time of day class met: __________________

9. Length of class period: __________________

10. What initiating activities are being attempted?: ____________________
    Use number only.
    1. Stating the goals of the lesson
    2. Outlining the lesson
    3. Using an analogue
    4. Using historical materials
    5. Reviewing subordinate information
    6. Giving students reasons for studying the new material
    7. Presenting a problematical situation

11. What is the new material being taught?
    (Include the specific goals you hope to achieve in teaching the new material.)

12. Comment on your performance after having taught the new material. You may wish to include here how well you feel you performed the initiating activities that you had planned, how they were received by your students and how you might change them if you were teaching the same material again to the same class:

APPENDIX C

A BIBLIOGRAPHY OF REFERENCES USEFUL IN PLANNING INITIATING ACTIVITIES

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    II. Prime Numbers and Perfect Numbers

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V. Space, Intuition, and Geometry

VI. Nature and History of π

VII. Computation of π

VIII. Mathematics and Music

IX. The Golden Measure

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V. The Contest Problem Book I
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XIII. Episodes From the Early History of Mathematics
XIV. Groups and Their Graphs
XV. Mathematics of Choice
XVI. From Pythagoras to Einstein
XVII. The M.A.A. Problem Book II
XVIII. First Concepts of Topology
XIX. Geometry Revisited

APPENDIX D

SUPERVISOR EVALUATION FORM

1. STUDENT'S NAME:

2. SUBJECT BEING TAUGHT:

3. GOAL OF THE LESSON (according to the student teacher)

4. SKETCH BRIEFLY HOW THE TEACHER INTRODUCED (I.E., INITIATED) THE LESSON. MENTION ANY USE OF THE SEVEN INITIATING ACTIVITIES LISTED BELOW: 1. Stating Goals, 2. Outlining, 3. Using an Analogue, 4. Using Historical Material, 5. Reviewing Subordinate Information, 6. Giving Reasons for Studying the New Material, 7. Presenting a Problematical Situation.

5. INCLUDE HERE ANY OF YOUR COMMENTS ON THE QUALITY OF THE INITIATING ACTIVITY USED.

APPENDIX E

STUDENT EVALUATION FORM

Circle the appropriate response and comment if you like.

Name of teacher:________________________________

Date of micro-teaching:__________________________

1. Was the teacher's method of introducing the lesson in itself interesting?	not very interesting	fairly interesting	very interesting
COMMENTS:			
2. Did the teacher's method of introducing the lesson help you to become interested in the lesson?	not too much	quite a bit	very much so
COMMENTS:			
3. Were you able to see a connection between the teacher's method of introducing the lesson and the main part of the lesson:	not much connection	some connection	very much connection
COMMENTS:			
4. Do you think that the teacher's introduction would help you (or that it did help you) to understand the lesson better?	very little	somewhat	quite a bit
COMMENTS:			
5. Do you feel that the teacher's introduction to the lesson will help you to remember the main part of the lesson better?	no help	some help	quite helpful
COMMENTS:			

VITA

Garth Eugene Runion was born on May 29, 1941 in Bloomington, Illinois. He attended Illinois State University from 1959 until 1963 when he graduated with a B.S. in Education degree. He received his M.A. in mathematics from the University of Northern Iowa in Cedar Falls in 1967.

He taught mathematics at Mattoon Senior High School in Mattoon, Illinois for three years from 1963 until 1966. He also taught mathematics at Glenbrook South High School in Glenview, Illinois for two years from 1967 until 1969.

He was a recipient of a National Science Foundation Academic Year Institute at the University of Northern Iowa for the school year 1966-67. During the school year 1969-70, he was a graduate assistant at the University of Illinois in Urbana. He was also a Trainer of Teachers of Teachers (TTT) Fellow at the University of Illinois for two years from 1970 until his graduation in 1972.

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